AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE OF PAGES
J	1 of 3

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO.(If applicable)
0003	04-Jun-2002	W22W9K-2056-4504	

6. ISSUED BY CODE DACW27	7. ADMINISTERED BY (If other than item 6) CODE DACA27
USA ENGINEER DISTRICT, LOUISVILLE ATTN: CELRL-CT 600 DR. MARTIN LUTHER KING PLACE ROOM 821 LOUISVILLE KY 40202	PROCUREMENT BRANCH ATTN: LISA M. FRAZIER P. O. BOX 59 LOUISVILLE KY 40201-0059

8. NAME AND ADDRESS OF CONTRACTOR (No., Street, County, State and Zip Code)

CODE | FACILITY CODE

X	9A. AMENDMENT OF SOLICITATION NO. DACW27-02-R-0004
X	9B. DATED (SEE ITEM 11) 11-Mar-2002
	10A. MOD. OF CONTRACT/ORDER NO.
	10B. DATED (SEE ITEM 13)

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

[X] The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offer [ ] is extended, [X] is not extended.

Offer must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended by one of the following methods: (a) By completing Items 8 and 15, and returning 1 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required)

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS.
IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

[ ] A.THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.

[ ] B.THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(B).

[ ] C.THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:

[ ] D.OTHER (Specify type of modification and authority)

E. IMPORTANT: Contractor [ ] is not, [ ] is required to sign this document and return ____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.)

Request for Proposal No. DACW27-02-R-0004 for Lock Construction, McAlpine Lock Replacement Project, Louisville, Kentucky, is hereby amended as follows:

SEE ATTACHED!

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print)		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)	
15B. CONTRACTOR/OFFEROR ________________ (Signature of person authorized to sign)	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA BY ________________ (Signature of Contracting Officer)	16C. DATE SIGNED 04-Jun-2002

SECTION SF 30 BLOCK 14 CONTINUATION PAGE

1. The PROJECT TABLE OF CONTENTS shall be DELETED in its entirety, and the attached PROJECT TABLE OF CONTENTS (Amdt. #0003) is substituted therefore.

2. Standard Form 1442, Solicitation, Offer and Award of Section 00010 is hereby deleted in its entirety and replaced with the attached with Standard Form 1442, Solicitation, Offer and Award (Amdt. No. 0003).

3. The Bid Schedule of Section 00010 is hereby deleted in its entirety and replaced with the attached Bid Schedule (Amdt. #0003).

4. Reference bulk email dated 14 May 2002. The bulk email indicated Amendment No. 0002 inserted submittal register sheets in error. Amendment No. 0003 hereby clarifies the only changes made by Amendment No. 0002 was to Submittal Register Sheet No. 15400. All other submittal register sheets included in Amendment No. 0002 are deleted in their entirety.

5. SECTIONS 00800, 02130, 02221, 02226, 02240, 02741, 03151, 03301, 03330, 03700, 03701, 05055, 11150, 11285, 11287, 15010, 15070, 15080, 15653, 15895, 15950, 15995, 16263 and 16751 are DELETED in their entirety, and sections with the same numbers (Amdt. #0003), attached, are substituted therefore. Note that the Title of 11150 has been changed.

6. Section 00115, Procedures for Submittal of Proposals, Paragraph 1.2, Submission Deadline, is hereby deleted in its entirety and replaced with the following:

   Submission Deadline. Technical proposals, which include Sections I, II, III, V, and VII, shall be received by the Corps of Engineers no later than 18 June 2002 by 4:30 p.m. local time, as specified in Section 00010, Block No. 13 of Standard Form 1442. All information requested by Sections I through VII must be submitted for the proposal to be considered. The price proposal and Subcontracting Plan, Sections IV and VI shall be received by the Corps of Engineers no later than 27 June 2002 by 4:30 p.m. local time.

7. Section 0115, Paragraph 1.4, Submission Format and Number of Submittals, is hereby amended as follows: The fourth sentence, which begins with “Section IV and VII”, is hereby deleted in its entirety and replaced with the following:

   Sections IV and VII should be submitted in original and two copies, Section VI should be submitted in original and seven copies; **Sections IV and VI shall be placed in a separate envelope and Section VII should be placed in an additional separate envelope.**

8. Section 00130, Proposal Evaluation System, Paragraph 3.1 d. Project Management, the first sentence is hereby amended to read “The evaluation team will evaluate the **four** areas shown below”.

9. SECTION 00300 Table is DELETED in its entirety, and SECTION 03300 Table (Amdt. #0003), attached, is substituted therefore. Note that this is the table only and not the entire section.

10. SECTIONS 05300 and 16770 are DELETED in their entirety.

11. The attached SECTIONS 15768, 16710 and 16721 shall be added in their entirety and incorporated herein.

12. The SUBMITTAL REGISTERS for SECTIONS 02741, 02226 and 11150 are DELETED in their entirety, and the attached SUBMITTAL REGISTER for SECTIONS 02741, 02226 and 11150 (Amdt. #0003) are substituted therefore.

13. The SUBMITTAL REGISTERS for SECTIONS 05300 and 16770 are DELETED in their entirety.

14. The attached SUBMITTAL REGISTERS for SECTIONS 15768, 16710 and 16721 shall be added in their entirety and incorporated herein.

15. The following CONTRACT DRAWINGS shall be DELETED in their entirety, and CONTRACT DRAWINGS with the same sheet reference numbers (Amdt. #0003), attached, shall be substituted therefore.
    Sheet Reference Numbers X-1, X-2, X-3, X-4D, F-1, F-7, F-15, F-22, C-2, C-2A, C-2D, C-11, C-12, C-47, C-48, C-52, C-53, C-72, C-77, S-1, S-4, E-9, E-11, E-13C, E-14A, S-30, S-40, S-66, S-90, S-100, S-119, S-127, S-143, S-155, S-177B, M-11, E-15, E-15A, E-18, E-19, E-19A, E-19B, E-20, E-21, E-23A, E-35, S-246, S-246A, M-22, M-23, M-24, S-268, S-268A, S-269, S-271, S-276A, S-282A, S-285, S-290, S-291, S-293, S-299, S-300, S-301, S-302, S-303, S-304, S-305, S-306, S-308, S-308A, S-308C, S-308D, S-308E, S-308F, S-316, S-317, S-318, S-319, S-320, M-26, E-47A, E-50, E-51, E-52, E-53, E-62, E-63, E-64, S-323, S-324, S-327, S-336A, S-349A, S-349B, S-374, S-374B, A-10C, E-75, E-76, E-77, E-78, E-79, E-80, E-83, E-84, E-90, E-91, E-95, E-97, E-98, C-82, S-383D, S-383E, S-383H, C-83 and S-403.

16. The attached CONTRACT DRAWINGS S-177D and E-64A (Amdt. #0003) shall be added in their entirety and incorporated herein.

17. The following REFERENCE DRAWINGS shall be DELETED in their entirety, and REFERENCE DRAWINGS with the same sheet reference numbers, attached, shall be substituted therefore.
    Sheet Reference Numbers C-1, C-2, C-5, C-10, C-14, C-16, C-22A, E-5 and S-2.

18. The following REFERENCE DRAWINGS shall be DELETED in their entirety.
    Sheet Reference Numbers S-34 and S-35.

19. This Amendment No. 0003 MUST be acknowledged as indicated in Item No. 11

SOLICITATION, OFFER, AND AWARD *(Construction, Alteration, or Repair)*	1. SOLICITATION NO. DACW27-02-R-0004	2. TYPE OF SOLICITATION [ ] SEALED BID (IFB) [X] NEGOTIATED *(RFP)*	3. DATE ISSUED 21-Mar-2002	PAGE OF PAGES 1 OF 157

IMPORTANT - The "offer" section on the reverse must be fully completed by offeror.

4. CONTRACT NO.	5. REQUISITION/PURCHASE REQUEST NO. W22W9K-2056-4504	6. PROJECT NO.

7. ISSUED BY CODE DACW27	8. ADDRESS OFFER TO *(If Other Than Item 7)* CODE
USA ENGINEER DISTRICT, LOUISVILLE ATTN: CELRL-CT 600 DR. MARTIN LUTHER KING PLACE ROOM 821 LOUISVILLE KY 40202 TEL:(502) 315-6207 FAX: (502) 315-6195	**See Item 7** TEL: FAX:

9. FOR INFORMATION CALL:	A. NAME LISA M FRAZIER	B. TELEPHONE NO. *(Include area code)* *(NO COLLECT CALLS)* (502) 315-6207

SOLICITATION

NOTE: In sealed bid solicitations "offer" and "offeror" mean "bid" and "bidder".

10. THE GOVERNMENT REQUIRES PERFORMANCE OF THE WORK DESCRIBED IN THESE DOCUMENTS *(Title, identifying no., date):*

LOCK CONSTRUCTION, MCALPINE LOCK REPLACEMENT PROJECT,LOUISVILLE, KENTUCKY. The work consists of construction of a 1200-foot navigation lock at the McAlpine Locks & Dam as well as construction of a fixed access bridge across both the new lock and an existing 1200-foot lock. The work includes construction of concrete chamber walls (RCC and Conventional), sills, culverts and discharge diffusers. Construction of these items will require rock excavation to founding grades. The work includes construction of steel miter gates and culvert valves. Construction includes all machinery and controls necessary to operate the lock. Construction of four service buildings on top of the lock walls is also required. Construction also includes all necessary backfilling and grading. The majority of the lock construction will occur within a cofferdam constructed and originally dewatered by others. Work will include operation and maintenance of the cofferdam. Work under this contract will also include demolition of the cofferdam. This demolition will include removal of concrete filled sheet pile cells, sand filled cells and stability berms, and detensioning of high capacity structural anchors in the south wall of the existing 1200-foot lock. SEE CONTINUATION

11. The Contractor shall begin performance within 10 calendar days and complete it within 1521 calendar days after receiving [ ] award, [X] notice to proceed. This performance period is [X] mandatory, [ ] negotiable. *(See* 00800, Par 1.3 *.)*

12 A. THE CONTRACTOR MUST FURNISH ANY REQUIRED PERFORMANCE AND PAYMENT BONDS? *(If "YES," indicate within how many calendar days after award in Item 12B.)* [X] YES [ ] NO	12B. CALENDAR DAYS 10

13. ADDITIONAL SOLICITATION REQUIREMENTS:

A. Sealed offers in original and 7 copies to perform the work required are due at the place specified in Item 8 by 04:30:00 *(hour)* local time 6/18/02 *(date)*. If this is a sealed bid solicitation, offers must be publicly opened at that time. Sealed envelopes containing offers shall be marked to show the offeror's name and address, the solicitation number, and the date and time offers are due.

B. An offer guarantee [X] is, [ ] is not required.

C. All offers are subject to the (1) work requirements, and (2) other provisions and clauses incorporated in the solicitation in full text or by reference.

D. Offers providing less than 120 calendar days for Government acceptance after the date offers are due will not be considered and will be rejected.

SOLICITATION, OFFER, AND AWARD
(Construction, Alteration, or Repair)

OFFER ***(Must be fully completed by offeror)***

14. NAME AND ADDRESS OF OFFEROR *(Include ZIP Code)*	15. TELEPHONE NO. *(Include area code)*
	16. REMITTANCE ADDRESS *(Include only if different than Item 14)* **See Item**
CODE / FACILITY CODE	

17. The offeror agrees to perform the work required at the prices specified below in strict accordance with the terms of this solicitation, if this offer is accepted by the Government in writing within ______ calendar days after the date offers are due. *(Insert any number equal to or greater than the minimum requirements stated in Item 13D. Failure to insert any number means the offeror accepts the minimum in Item 13D.)*

AMOUNTS: SEE SCHEDULE OF PRICES

18. The offeror agrees to furnish any required performance and payment bonds.

19. ACKNOWLEDGMENT OF AMENDMENTS
(The offeror acknowledges receipt of amendments to the solicitation -- give number and date of each)

AMENDMENT NO.									
DATE									

20A. NAME AND TITLE OF PERSON AUTHORIZED TO SIGN OFFER *(Type or print)*	20B. SIGNATURE	20C. OFFER DATE

AWARD ***(To be completed by Government)***

21. ITEMS ACCEPTED:
SEE SCHEDULE

22. AMOUNT	23. ACCOUNTING AND APPROPRIATION DATA

24. SUBMIT INVOICES TO ADDRESS SHOWN IN *(4 copies unless otherwise specified)*	**ITEM: Sec 00100 Para. 236-27**	25. OTHER THAN FULL AND OPEN COMPETITION PURSUANT ☐ 10 U.S.C. 2304(c) ☐ 41 U.S.C. 253(c)

26. ADMINISTERED BY CODE	27. PAYMENT WILL BE MADE BY CODE
US ARMY ENGR DIST., LOUISVILLE P. O. BOX 59 CELRL-CT-P LOUISVILLE, KY 40201-0059	USACE, FINANCE CENTER (UFC) 5700 WASP AVENUE EFT:T MILLINGTON,TN 38054

CONTRACTING OFFICER WILL COMPLETE ITEM 28 OR 29 AS APPLICABLE

☐ 28. NEGOTIATED AGREEMENT *(Contractor is required to sign this document and return _______ copies to issuing office.)* Contractor agrees to furnish and deliver all items or perform all work, requisitions identified on this form and any continuation sheets for the consideration stated in this contract. The rights and obligations of the parties to this contract shall be governed by (a) this contract award, (b) the solicitation, and (c) the clauses, representations, certifications, and specifications or incorporated by reference in or attached to this contract.

☐ 29. AWARD *(Contractor is not required to sign this document.)* Your offer on this solicitation, is hereby accepted as to the items listed. This award consummates the contract, which consists of (a) the Government solicitation and your offer, and (b) this contract award. No further contractual document is necessary.

30A. NAME AND TITLE OF CONTRACTOR OR PERSON AUTHORIZED TO SIGN *(Type or print)*		31A. NAME OF CONTRACTING OFFICER *(Type or print)*	
30B. SIGNATURE	30C. DATE	31B. UNITED STATES OF AMERICA BY	31C. AWARD DATE

Demolition of the existing swing bridge, bascule bridge and portions of existing concrete and sandstone masonry lock walls are also required. The work also includes construction of upstream and downstream approach walls. These walls will consist of precast concrete beams supported by either concrete caissons drilled into the rock foundation or concrete filled circular sheet pile cells. The approach wall support type is an alternate to be chosen by the offeror. It will be necessary to construct portions of both approach walls outside the cofferdam in the wet. The access bridge will consist of prestressed concrete beams with CIP concrete deck supported by concrete piers founded on drilled caissons. This is a Request for Proposals and offers will be evaluated on the following technical basis, listed in descending order of importance: (1) Experience; (2) Past Performance; (3) Technical Approach; (4) Project Management; and (5) Subcontracting Plan. All evaluation factors other than price, when combined, are approximately equal to the price proposal.

The Estimated Construction Cost Range of this project is from $100,000,000.00 to $250,000,000.00.
The NAICS code for this solicitation is 234990

PROPOSAL MODIFICATIONS RECEIVED BY FACSIMILE OR TELETYPE WILL NOT BE CONSIDERED.

AWARD IS BEING MADE PURSUANT TO THE SMALL BUSINESS COMPETITIVENESS DEMONSTRATION PROGRAM.

THE SPECIFICATION REFERENCES LISTED WITH EACH BID ITEM ARE PROVIDED FOR REFERENCE ONLY. THESE REFERENCES ARE NOT ALL INCLUSIVE OF THE CONTRACT PROVISIONS APPLICABLE TO EACH BID ITEM.

***3 THE INFORMATION BELOW IS ALSO CONTAINED IN SECTION 00800 OF THE SOLICITATION**

In addition to the Performance Bond requirements of "Warranty of Construction", the Performance Bond(s) will remain in effect for any occurrence of Latent Defect for a period of six years beyond the warranty period."

For the purposes of the "Contract Disputes Act", the Surety shall be considered the same as a contractor to the Government."

BID SCHEDULE
AMDT. #0003

ITEM NO.	SUPPLIES/SERVICES	EST. QTY	UNIT	UNIT PRICE	AMOUNT
	DESCRIPTION				
0001	Mobilization, Demobilization and Preparatory Work (Spec. Sect. 00800)		LS		$________
0002	Removal and Storage of Salvageable Generators (Spec. Sect. 00800)		LS		$________
0003	Storm Water Pollution Prevention Measures (Spec. Sect. 01356)		LS		$________
0004	Core Hole Overburden Drilling (Spec. Sect. 02210)	1,000	LF	$_____	$________
0005	Core Drilling, Vertical Holes (PQ) (Spec. Sect. 02210)	2,320	LF	$_____	$________
0006	Core Drilling, Vertical Holes (NQ) (Spec. Sect. 02210)	500	LF	$_____	$________
0007	39 - Strand Anchors (Spec. Sect. 02490)	600	LF	$_____	$________
0008	Bar Anchors (Spec. Sect. 02490)	440	LF	$_____	$________
0009	Grout for Anchors (Spec. Sect. 02490)	1,350	CF	$_____	$________
0010	Redrilling for Anchors (Spec. Sect. 02490)	1,070	LF	$_____	$________
0011	Preliminary Cleanup (Spec. Sect. 02217, 02226)	62,200	SY	$_____	$________
0012	Final Cleanup & Foundation Preparation (Spec. Sect. 02217)	85,400	SY	$_____	$________
0013	Allowance for Flooding and Evacuation (Spec. Sect. 02170)	1	EA	$_____	$________
0014	Flooding Lost Time (Spec. Sect. 02170)	1	DAY	$_____	$________
0015	Demolition (Spec. Sect. 02220)		LS		$________
0016	Demolition of Bascule Bridge (Spec. Sect. 02220)		LS		$________
0017	Demolition of Swing Bridge (Spec. Sect. 02220)		LS		$________

ITEM NO.	SUPPLIES/SERVICES	EST. QTY	UNIT	UNIT PRICE	AMOUNT
0018	Demolition of Existing Cofferdam (Spec. Sect. 02221)		LS		$________
0019	Rewatering Cofferdam (Spec. Sect. 02170)		LS		$________
0020	Storage of Reusable Cofferdam Sheet Piling (Spec. Sect. 02221)	114,500	LF	$_____	$________
*1 **0021**	**Not Used**				*1
0022	Conventional Rock Excavation (Spec. Sect. 02226)	67,000	CY	$_____	$________
0023	Buffer Zone Excavation (Spec. Sect. 02226)	15,000	CY	$_____	$________
0024	Special Excavation (Spec. Sect. 02226)	65,600	CY	$_____	$________
0025	Excavation Adjacent to Structures (Spec. Sect. 02226)	3,155	CY	$_____	$________
0026	Line Drilling (Spec. Sect. 02226)	62,000	SY	$_____	$________
0027	Pre-Blast Survey (Spec. Sect. 02226)		LS		$________
0028	Slurry Trench (Spec. Sect. 02261)		LS		$________
0029	Stone Protection (Spec. Sect. 02270)	2,200	TON	$_____	$________
0030	Grouting (Spec. Sect. 2270)	447	CY	$_____	$________
0031	Earthwork (Spec. Sect. 02300)		LS		$________
0032	Operation and Maintenance of Completed Work (Including Power, Maintenance, Monitoring and Repair for all Water Control, Instrumentation and Other Completed Work) (Sec. Sect. 02130, 02170, 13500)		LS		$________
0033	Drilled Foundation Caissons (Bridge) (Spec. Sect. 02466)	5,990	LF	$_____	$________
0034	Underdrains		LS		$________

ITEM NO.	SUPPLIES/SERVICES	EST. QTY	UNIT	UNIT PRICE	AMOUNT
	(Spec. Sect. 02316, 02620)				
0035	Storm Drainage System (Spec. Sect. 02316, 02630, 03415)		LS		$____________
0036	Water Distribution (Spec. Sect. 02316, 02510)		LS		$____________
0037	Drainage Layer (Spec. Sect. 02714)	10,600	TON	$_____	$____________
0038	DGA Subbase (Spec. Sect. 02721)	12,800	TON	$_____	$____________
0039	Asphalt Binder Course (Spec. Sect. 02741)	1,280	TON	$_____	$____________
0040	Asphalt Surface Course (Spec. Sect. 02741)	1,300	TON	$_____	$____________
0041	Bituminous Tack Coat (Spec. Sect. 02748)	5	TON	$_____	$____________
0042	Bituminous Prime Coat (Spec. Sect. 02748)	12	TON	$_____	$____________
0043	Pavement Marking (Spec. Sect. 02763)		LS		$____________
0044	Fencing (Spec. Sect. 02821)		LS		$____________
*3 *2 **0045**	**Vehicle Gate Operator Systems** **(Spec. Sect. 11150)**		**LS**		**$____________** ***2 *3**
0046	Guardrail Systems (Spec. Sect. 02850)		LS		$____________
0047	Seeding (Spec. Sect. 02921)		LS		$____________
0048	Sodding (Spec. Sect. 02922)		LS		$____________
0049	Waterstop (Spec. Sect. 03151)		LS		$____________
0050	Reinforcing Steel, excluding Approach Walls (Spec. Sect. 03201)		LS		$____________
0051	Portland Cement, excluding Approach Walls (Spec. Sect. 03300,03701)	45,720	TON	$_____	$____________

ITEM NO.	SUPPLIES/SERVICES	EST. QTY	UNIT	UNIT PRICE	AMOUNT
*2 0051AA	Portland Cement, excluding Approach Walls, All Over **45,720 TON** (Spec. Sect. 03300,03701)	4,572	TON	$_____	$___________*2
0052	Pozzolan, excluding Approach Walls (Spec. Sect. 03300,03701)	16,100	TON	$_____	$___________
*2 0052AA	Pozzolan, excluding Approach Walls, All Over **16,100 TON** (Spec. Sect. 03300,03701)	1,610	TON	$_____	$___________*2
0053	Water Reducing Agent, First, excluding Approach Walls (Spec. Sect. 03300, 03701)	21,600	GAL	$_____	$___________
*2 0053AA	Water Reducing Agent, All Over, excl. Approach Walls, All Over **21,600 GAL** (Spec. Sect. 03300, 03701)	2,160	GAL	$_____	$___________*2
0054	High Range Water Reducing Admixture, First, Excluding Approach Walls (Spec. Sect. 03300, 03701)	1,300	GAL	$_____	$___________
*2 0054AA	High Range Water Reducing Admixture, All Over **1,300 GAL**, Excluding Approach Wall (Spec. Sect. 03300, 03701)	130	GAL	$_____	$___________*2
0055	Air Entraining Admixture, First Excluding Approach Walls (Spec. Sect. 03300)	11,400	GAL	$_____	$___________
*2 0055AA	Air Entraining Admixture, All Over **11,400 GAL** Excluding Approach Walls (Spec. Sect. 03300)	1,140	GAL	$_____	$___________*2
0056	Anti-Washout Agent, First Excluding Approach Walls (Spec. Sect. 03300)	800	GAL	$_____	$___________
*2 0056AA	Anti-Washout Agent, All Over **800 GAL** Excluding Approach Walls (Spec. Sect. 03300)	80	GAL	$_____	$___________*2
0057	Structural Cast-in-Place Concrete, excluding Approach Walls (Spec. Sect. 03301)	15,750	CY	$_____	$___________
0058	Granite Obelisk (Spec. Sect. 04465)		LS	$_____	$___________
***3 0058A**	**Sandstone Benches and Bollards (Spec. Sect. 02240)**		**LS**	**$_____**	**$___________*3**

ITEM NO.	SUPPLIES/SERVICES	EST. QTY	UNIT	UNIT PRICE	AMOUNT
0059	Precast Concrete, excluding Approach Walls (Spec. Sect. 03415, 11175)		LS		$__________
0060	Mass Concrete (Spec. Sect. 03700)	217,500	CY	$_____	$__________
0061	Roller Compacted Concrete (Spec. Sect. 03701)	121,500	CY	$_____	$__________
0062	Dental Concrete/Mortar (Spec. Sect. 02217)	1,000	CY	$_____	$__________
*2 0063	RCC Test Section (Spec. Sect. 03701)	**2**	**EA**	$_____	$__________ *2
0064	Miscellaneous Concrete (Spec. Sect. 03301)	2,270	CY	$_____	$__________
0065	Miscellaneous Metals, Excluding Approach Walls (Spec. Sect. 05500, 05120, 05502)		LS		$__________
*3 *** 0066**	Miter Gates (Spec. Sect. 05055, 05090, 05502, 11285)		LS		$__________ *3
*3 *** 0067**	Culvert Valves & Maintenance Bulkheads (Spec. Sect. 05055, 05502, 11287)		LS		$__________ *3
*3 *** 0068**	Floating Mooring Bitts (Spec. Sect. 05055, 11290)		LS		$__________ *3
*3 *2 *** 0069**	Instrumentation (Spec. Sect. 13500, 13501, 13502, 13503, 13504, 13505, 13527, 13532)		LS		$________ *2,*3
*3 *** 0070**	Hydraulic Power Systems (Spec. Sect. 15010)		LS		$__________ *3
*3 *** 0071**	Raw Water System (05090, 05093, 11310, 15070, 15400)		LS		$__________ *3
*3 *** 0072**	Compressed Air System (05090, 05093, 15070, 15400)		LS		$__________ *3
*3 *2 *** 0073**	Control Buildings (Spec. Sect. 04220, 06100, 06410, 07412, 05090, 05093, 07600, 07840, 07900, 08810, 08210, 08316, 08520, 08700, 08810, 09250, 09510, 09690, 09900, 10270, 10430, 10440, 10508, 10520, 10800, 11310, 11311, 13080,13202, 15070, 15080, 15400, 15653, 15895, 15990, 15995)		LS		$________ *2,*3
*3 *** 0074**	Lock Electrical System (Spec. Sect. 16263, 16370, 16751, 16768, 16770,		LS		$__________ *3

ITEM NO.	SUPPLIES/SERVICES	EST. QTY	UNIT	UNIT PRICE	AMOUNT
*1	**16800**, 16900, 16910, 16920)				*1
	Alternate 1: Approach Wall Drilled Shaft Design				
0075	Government Furnished Sheet Piling for Approach Wall End Cells (Spec. Sect. 02464)	11,000	LF	$_____	$___________
0076	Drilled Foundation Caissons (Spec. Sect. 02226, 02466)	495	LF	$_____	$___________
0077	Reinforcing Steel (Spec. Sect. 03201)		LS		$___________
0078	Portland Cement (Spec. Sect. 03300,03701)	3,000	TON	$_____	$___________
0079	Pozzolan (Spec. Sect. 03300,03701)	736	TON	$_____	$___________
0080	Water Reducing Agent, First (Spec. Sect. 03300, 03701)	3,900	GAL	$_____	$___________
*2 0080AA	Water Reducing Agent, All Over **3,900 GAL** (Spec. Sect. 03300, 03701)	390	GAL	$_____	$___________ *2
0081	Air Entraining Admixture, First (Spec. Sect. 03300, 03701)	1,525	GAL	$_____	$___________
*2 0081AA	Air Entraining Admixture, All Over **1,525 GAL** (Spec. Sect. 03300, 03701)	153	GAL	$_____	$___________ *2
0082	Structural Cast-in-Place Concrete (Spec. Sect. 03301,02132)	8,560	CY	$_____	$___________
0083	Precast Concrete (Spec. Sect. 03415)		LS		$___________
0084	Miscellaneous Metals (Spec. Sect. 05500)		LS		$___________
	Alternate 2: Approach Wall Cell Design				
0085	Government Furnished Sheet Piling for Approach Wall End Cells (Spec. Sect. 02464)	11,000	LF	$_____	$___________
0086	Government Furnished Sheet Piling for Approach Wall Intermediate Cells (Spec. Sect. 02464)	12,432	LF	$_____	$___________
0087	Contractor Furnished Sheet Piling for Approach Wall	12,432	LF	$_____	$___________

ITEM NO.	SUPPLIES/SERVICES	EST. QTY	UNIT	UNIT PRICE	AMOUNT
	Intermediate Cells (Spec. Sect. 02464)				
0088	Reinforcing Steel (Spec. Sect. 03201)		LS		$__________
0089	Portland Cement (Spec. Sect. 03300,03701)	6,000	TON	$_____	$__________
0090	Pozzolan (Spec. Sect. 03300,03701)	1,200	TON	$_____	$__________
0091	Water Reducing Agent (Spec. Sect. 03300, 03701)	2,500	GAL	$_____	$__________
*2 0091AA	Water Reducing Agent, All Over **2,500 GAL** (Spec. Sect. 03300, 03701)	250	GAL	$_____	$__________ *2
0092	Air Entraining Admixture, First (Spec. Sect. 03300, 03701)	1,780	GAL	$_____	$__________
0092AA	Air Entraining Admixture, All Over (Spec. Sect. 03300, 03701)	178	GAL	$_____	$__________
0093	Structural Cast-in-Place Concrete (Spec. Sect. 03301)	22,120	CY	$_____	$__________
0094	Precast Concrete (Spec. Sect. 03415)		LS		$__________
0095	Miscellaneous Metals (Spec. Sect. 05500)		LS		$__________
	TOTAL BASE BID (Items 1-74 plus either Items 75- 84 or Items 85-95)				$__________
	OPTION 1 – Reduction in cost for reusable cofferdam sheet piling becoming contractor owned material Reusable Cofferdam Sheet Piling (Spec. Sect. 02221)		LS		$__________
	OPTION 2 – Reduction in cost for salvageable generators becoming contractor owned material Salvageable Generators (Spec. Sect. 02221)		LS		$__________

ITEM NO.	SUPPLIES/SERVICES	EST. QTY	UNIT	UNIT PRICE	AMOUNT
	OPTION PRICES SHALL BE GOOD FOR THE PROJECT DURATION IF AND WHEN EXCERCISED. THE PROJECT DURATION WILL NOT BE AFFECTED BY THE EXERCISING OF THE OPTION. Special Proposal Conditions. If a modification to a bid based on unit prices is submitted, which provides for a lump sum adjustment to the total estimated cost, the application of the lump sum adjustment to each unit price in the bid schedule must be stated. If it is not stated, the bidder agrees that the lump sum adjustment shall be applied on a pro rata basis to every unit price in the bid schedule.				
*3	*** Payment on this bid item will be no more than 93% of the total amount prior to successful completion of the "Sea Trials" required by paragraph 1.86 of specification section 00800. Upon completion and acceptance of the "Sea Trials", payment will be advanced to 100%. This is separate from any other retainage the Government may hold under this contract.**				

*3 **FIELD OFFICE OVERHEAD**

NOTICE TO BIDDERS: For your bid to be responsive, you must declare below the single accounting practice that you apply to contracts to calculate field office overhead for all change orders, modifications, and requests for equitable adjustment. Pursuant to Federal Acquisition Regulations (FAR) Parts 31.105(d)(3) and 31.203(d)(1), an accounting practice that varies from modification to modification is not allowable. Select one of the following:

CHECK APPROPRIATE LINE

1. TIME DISTRIBUTION BASE FOR A PER DIEM RATE

   If you use this practice, see Special Clause "Field Office Overhead Per Diem Rate" ______

2. DIRECT COST DISTRIBUTION BASE FOR A PERCENTAGE MARKUP

   If you use this practice, see Special Clause "Field Office Overhead Percentage Markup" ______

3. OTHER ACCOUNTING PRACTICE THAT IS ALLOWABLE UNDER THE FAR AND USES A <u>SINGLE</u> DISTRIBUTION BASE ______

YOU MUST DESCRIBE THE ACCOUNTING PRACTICE IN SUFFICIENT DETAIL BELOW TO ALLOW THE CONTRACTING OFFICER TO DETERMINE WHAT ACCOUNTING PRACTICE IS BEING UTILIZED BY YOUR COMPANY AND THAT IT COMPLIES WITH THE FAR.

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<u>FAILURE TO FULLY COMPLY WITH THE ABOVE REQUIREMENT OR, IF ALTERNATIVE IS DECLARED AND YOUR DESCRIPTION DOES NOT CLEARLY STATE OR DESCRIBED A CONSISTENT ACCOUNTING PRACTICE USING A SINGLE DISTRIBUTION BASE, WILL BE CAUSE FOR YOUR BID TO BE REJECTED AS NON-RESPONSIVE.</u>

PROJECT TABLE OF CONTENTS

DIVISION 00 – CONTRACT REQUIREMENTS

DIVISION 01 - GENERAL REQUIREMENTS

DIVISION 02 - SITE WORK

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DOCUMENT TABLE OF CONTENTS

DIVISION 00 - DOCUMENTS

SECTION 00800

SPECIAL CONTRACT REQUIREMENTS

03/01

-- End of Document Table of Contents --

SECTION 00800

SPECIAL CONTRACT REQUIREMENTS

03/01

PART 1 GENERAL

1.1 NOT USED (REFERENCES)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals not having a "GA" designation are for information only. When used, a designation following the "GA" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment-in-Place List; FIO

The Contractor shall be required to make a list of all installed equipment furnished under this contract.

Maintenance and Parts Data; FIO

The Contractor will be required to furnish a brochure, catalog cut, parts list, manufacturer's data sheet or other publication which will show detailed parts data.

Request to Interrupt Utilities; GA,RE

Request for permission to shut down utility service shall be submitted in writing not less than 72 hours prior to date of proposed interruption.

SF 1413, "Statement and Acknowledgement"; FIO

Within 7 days after the award of any subcontract, the Contractor shall deliver to the Contracting Officer a completed SF 1413.

Equipment Warranty Identification Tags; GA,RE

Sample tags representative of how the Contractor will complete other tags.

System of Property Control; GA,RE

Plan for the control of all salvage material and equipment

Purchase Orders; FIO

Five copies of all purchase orders.

Progress Photographs; FIO

Identification of Technical Data; FIO

Traffic Control Plan; GA,RE

Before starting construction of the road and bridge, a Traffic Control Plan shall be developed by the Contractor and approved by the Contracting Officer.

Plan for Maintaining Navigation; GA,RE

Cofferdam Evacuation Plan; GA,RE

Personnel Stairs and Ladders; GA,RE

The Contractor's plan for maintaining the cofferdam exitways during interference of construction activities, including drawings and supporting calculations for any stairway modifications.

SD-04 Drawings

As-Built Documents; GA,RE.

Drawings and specifications showing final as-built conditions of the project. The CADD drawing submittals shall consist of two (2) separate types of media. One set of media shall consist of the electronic CADD drawing files. The second media type, shall consist of one set of mylars, 2 sets of blue line prints of the mylars, and the approved marked working as-built prints.

Mechanical Room Layout; GA,ED.

SD-08 Statements

Contractor CADD Technician Qualifications; GA,RE

The Contractor will be required to provide a statement of qualifications of the CADD Operator(s) responsible for completion of the As-built drawings.

SD-09 Reports

Small Tool Useage Plan; GA,RE

The Contractor's plan for use of small tools shall be submitted for determination of estimated consumption.

Labor, Equipment and Material Reports; FIO.

SD-13 Certificates

Warranties; FIO

Insurance; FIO

1.3 COMMENCEMENT, PROSECUTION AND COMPLETION OF WORK (APR 1984) FAR 52.211-10.
2 Jan 96

A "First Notice to Proceed" will be issued under which only administrative work will be initiated. Because the previous Cofferdam contract activity at the job site will not be complete and is likely to conflict with this Lock Contract, no physical Lock Contract work will be performed at the job site until about the time of 1 January 2003. The Lock contractor should not expect to be allowed to conduct any site work until after said date and a "Second Notice to Proceed" is issued.
***1**
Should the "Second Notice to Proceed" not be issued until a later time, circumstances for the delay will be evaluated and any adjustment required will be executed in accordance with the Changes clause. A Default Clause time extension may be granted as appropriate.
***1**

When all submissions, plans and prerequisites for site work have been satisfied and a "Second Notice to Proceed" is issued, the physical site work shall be conducted by the Lock Contractor. The contractor shall be required to proceed with physical work, including operation and maintenance of the cofferdam dewatering system, within 10 calendar days of receipt of the "Second Notice to Proceed", prosecute said work diligently, and complete the entire work ready for use not later than 1,521 calendar days after date of receipt of the "Second Notice to Proceed." The time stated for completion shall include as-built drawings, O&M manuals, operational tests/reports/training/instructions, equipment lists, and final cleanup of the premises. The time for all contract schedule, progress and liquidated damage determinations will be based on the date of the "Second Notice to Proceed."

1.4 LIQUIDATED DAMAGES--CONSTRUCTION (SEP 2000) FAR 52.211-12.
Oct 00

a. If the Contractor fails to complete the work within the time specified in the contract, the Contractor shall pay liquidated damages to the Government in the amount of $7,200.00 for each calendar day of delay until the work is completed or accepted.

b. If the Government terminates the Contractor's right to proceed, liquidated damages will continue to accure until the work is completed. These liquidated damages are in addition to excess costs of repurchase under the Termination clause.

1.5 TIME EXTENSIONS (SEPT 2000) FAR 52.211-13
Oct 00

Time extensions for contract changes will depend upon the extent, if any, by which the changes cause delay in the completion of the various elements of construction. The change order granting the time extension may provide that the contract completion date will be extended only for those specific elements related to the changed work and that the remaining contract completion dates for all other portions of the work will not be altered. The change order also may provide for an equitable readjustment of liquidated damages under the new completion schedule.

1.6 NOT USED (EXCLUSION OF PERIODS IN COMPUTING COMPLETION SCHEDULES)

1.7 CONTRACT DRAWINGS AND SPECIFICATIONS (AUG 2000) DFARS 252.236-7001
19 Sept 2000

(Sept 2000)

a. At award, the Government will furnish the Contractor a compact disk containing all technical contract documents. This disk will include a complete set of drawing files and technical specification files which have all amendments incorporated. The disk will contain drawing files in CALS Type 4 format and technical specifications in PDF format.

The CALS files and the PDF files are being provided for the Contractor's use in printing hard copies of contract documents.

In addition, native CADD files and Specsintact files are provided in accordance with "AS-BUILTS DOCUMENTS" paragraph for the Contractor's use in developing as-built plans and specifications.

b. The Contractor shall--

(1) Check all drawings furnished immediately upon receipt;

(2) Compare all drawings and verify the figures before laying out the work;

(3) Promptly notify the Contracting Officer of any discrepancies; and

(4) Be responsible for any errors which might have been avoided by complying with paragraph b.(1), b.(2), and b.(3); and

(5) Reproduce and print contract drawings and specifications as needed.

c. Omissions from the drawings or specifications or the misdescription of details of work which are manifestly necessary to carry out the intent of the drawings and specifications, or which are customarily performed, shall not relieve the Contractor from performing such omitted or misdescribed details of the work. The Contractor shall perform such details as if fully and correctly set forth and described in the drawings

and specifications.
***3 *1**

d. The work shall conform to the specifications and the contract drawings identified on the following index of drawings. The contract drawings are all revision 0 and are all dated 8 March 2002, except for the following. Contract drawings revised as part of Amendment 001 have a revision date of 19 April 2002. Contract drawings revised as part of Amendment 002 have a revision date of 10 May 2002. Contract drawings revised as part of Amendment 003 have a revision date of 4 June 2002.
***1 *3**

TABLE OF DRAWINGS

VOLUME 1 GENERAL INFORMATION, DEMOLITION, SITE INFORMATION,LOCK AND FILLING & EMPTYING SYSTEM

DWG CODE	SH. REF. NO.	TITLE
	GENERAL	
MCA100.1	X-0	COVER SHEET VOLUME 1
MCA100.1	X-1	INDEX SHEET 1
MCA100.1	X-2	INDEX SHEET 2
MCA100.1	X-3	INDEX SHEET 3
MCA100.1	X-4	INDEX SHEET 4
MCA100.1	X-4A	INDEX SHEET 5
MCA100.1	X-4B	INDEX SHEET 6
MCA100.1	X-4C	INDEX SHEET 7
MCA100.1	X-4D	INDEX SHEET 8
MCA100.1	X-5	PICTORIAL VIEW OF PROJECT
MCA100.1	X-6	LOCATION PLAN AND VICINITY MAP
MCA100.1	X-7	GENERAL PLAN
MCA100.1	X-7A	PLAN-EXPECTED CONSTRUCTION CONDITIONS
MCA100.1	X-8	SURVEY CONTROL
MCA100.1	X-9	REQUIRED BRIDGE CONSTRUCTION SEQUENCE
MCA100.1	X-10	NOT USED
MCA100.1	X-11	NOT USED
MCA100.1	X-12	NOT USED
MCA100.1	X-13	NOT USED
MCA100.1	X-14	NOT USED
	FOUNDATION	
MCA105.1	F-1	PLAN TOP OF ROCK
MCA105.1	F-2	OVERALL PLAN OF PROFILES AND SECTIONS
MCA105.1	F-3	CROSS SECTION STATION 15+00
MCA105.1	F-4	CROSS SECTION STATION 17+00
MCA105.1	F-5	CROSS SECTION STATION 18+25
MCA105.1	F-6	CROSS SECTION STATION 20+00
MCA105.1	F-7	CROSS SECTION STATION 21+50
MCA105.1	F-8	CROSS SECTION STATION 23+00
MCA105.1	F-9	CROSS SECTION STATION 25+00
MCA105.1	F-10	CROSS SECTION STATION 26+70

MCA105.1	F-11	CROSS SECTION STATION 30+00
MCA105.1	F-12	CROSS SECTION STATION 31+50
MCA105.1	F-13	CROSS SECTION STATION 32+70
MCA105.1	F-14	CROSS SECTION STATION 33+50
MCA105.1	F-15	NORTH LOCK WALL ROCK PROFILE (SHEET 1 OF 2)
MCA105.1	F-16	NORTH LOCK WALL ROCK PROFILE (SHEET 2 OF 2)
MCA105.1	F-17	SOUTH LOCK WALL ROCK PROFILE (SHEET 1 OF 2)
MCA105.1	F-18	SOUTH LOCK WALL ROCK PROFILE (SHEET 2 OF 2)
MCA105.1	F-19	FOUNDATION EXCAVATION PLAN (SHEET 1 OF 3)
MCA105.1	F-20	FOUNDATION EXCAVATION PLAN (SHEET 2 OF 3)
MCA105.1	F-21	FOUNDATION EXCAVATION PLAN (SHEET 3 OF 3)
MCA105.1	F-22	EXCAVATION METHOD PLAN (SHEET 1 OF 3)
MCA105.1	F-23	EXCAVATION METHOD PLAN (SHEET 2 OF 3)
MCA105.1	F-24	EXCAVATION METHOD PLAN (SHEET 3 OF 3)

DEMOLITION

***1**

MCA110.1	C-1	COFFERDAM DEMOLITION PLAN SHEET 1 OF 2
MCA110.1	C-2	COFFERDAM DEMOLITION PLAN SHEET 2 OF 2
MCA110.1	C-2A	**NOSE PIER DEMOLITION DETAILS**
MCA110.1	C-2B	**BASCULE BRIDGE DEMOLITION DETAILS**
MCA110.1	C-2C	**SWING BRIDGE DEMOLITION DETAILS**
MCA110.1	C-2D	NOSE PIER RESTORATION DETAILS
MCA120.1	C-3	DISPOSAL AREA AND OVERALL LOCATION PLAN
MCA120.1	C-4	U.S. GOVERNMENT PROPERTY LINE (SHEET 1 of 3)
MCA120.1	C-5	U.S. GOVERNMENT PROPERTY LINE (SHEET 2 of 3)
MCA120.1	C-6	U.S. GOVERNMENT PROPERTY LINE (SHEET 3 of 3)
MCA120.1	C-7	STORAGE AREA ONE
MCA120.1	C-8	STORAGE AREA TWO
MCA120.1	C-9	DISPOSAL AREA AND STORAGE AREA THREE
MCA120.1	C-10	OVERALL DEMOLITION PLAN
MCA120.1	C-11	DEMOLITION PLAN (SHEET 1 of 4)
MCA120.1	C-12	DEMOLITION PLAN (SHEET 2 of 4)
MCA120.1	C-12A	ENLARGED DEMOLITION PLAN
MCA120.1	C-12B	LOCK DEMOLITION PHOTOGRAPHS
MCA120.1	C-13	DEMOLITION PLAN (SHEET 3 of 4)
MCA120.1	C-14	DEMOLITION PLAN (SHEET 4 of 4)
MCA120.1	C-14A	DEMILITION WALL TREATMENT
MCA120.1	C-14B	NOT USED

SITE INFORMATION AND ACCESS ROADS

***1**

SITE CIVIL

MCA160.1	C-15	OVERALL SITE PLAN
MCA160.1	C-16	SITE PLAN (SHEET 1 of 4)
MCA160.1	C-17	SITE PLAN (SHEET 2 of 4)
MCA160.1	C-17A	SITE PLAN (SHEET 3 of 4)
MCA160.1	C-17B	SITE PLAN (SHEET 4 of 4)
MCA160.1	C-18	ESPLANADE SITE PLAN (SHEET 1 of 3)
MCA160.1	C-19	ESPLANADE SITE PLAN (SHEET 2 of 3)
MCA160.1	C-20	ESPLANADE SITE PLAN (SHEET 3 of 3)
MCA160.1	C-21	OVERALL GRADING AND DRAINAGE PLAN
MCA160.1	C-22	GRADING PLAN (SHEET 1 of 2)
MCA160.1	C-23	GRADING PLAN (SHEET 2 of 2)

MCA160.1	C-24	ESPLANADE GRADING PLAN (SHEET 1 of 3)
MCA160.1	C-25	ESPLANADE GRADING PLAN (SHEET 2 of 3)
MCA160.1	C-26	ESPLANADE GRADING PLAN (SHEET 3 of 3)
MCA160.1	C-27	NEW FENCING - DEMOLITION AND SITE PLAN
MCA160.1	C-28	DISPOSAL AREA GRADING PLAN
MCA160.1	C-29	OVERALL EROSION CONTROL PLAN
MCA160.1	C-30	EROSION CONTROL PLAN (SHEET 1 of 4)
MCA160.1	C-31	EROSION CONTROL PLAN (SHEET 2 of 4)
MCA160.1	C-32	EROSION CONTROL PLAN (SHEET 3 of 4)
MCA160.1	C-33	EROSION CONTROL PLAN (SHEET 4 of 4)
MCA160.1	C-34	EROSION CONTROL DETAILS
MCA160.1	C-35	MAINTENANCE ACCESS ROADS PROFILES
MCA160.1	C-36	STORM DRAIN PROFILES
MCA160.1	C-37	STORM DRAIN DETAILS
MCA160.1	C-38	MAINTENANCE ACCESS ROAD A CROSS SECTIONS (SHEET 1 of 4)
MCA160.1	C-39	MAINTENANCE ACCESS ROAD A CROSS SECTIONS (SHEET 2 of 4)
MCA160.1	C-40	MAINTENANCE ACCESS ROAD A CROSS SECTIONS (SHEET 3 of 4)
MCA160.1	C-41	MAINTENANCE ACCESS ROAD A CROSS SECTIONS (SHEET 4 of 4)
MCA160.1	C-41A	MAINTENANCE ACCESS ROAD B CROSS SECTIONS
MCA160.1	C-41B	MAINTENANCE ACCESS ROAD C CROSS SECTIONS (SHEET 1 of 3)
MCA160.1	C-41C	MAINTENANCE ACCESS ROAD C CROSS SECTIONS (SHEET 2 of 3)
MCA160.1	C-41D	MAINTENANCE ACCESS ROAD C CROSS SECTIONS (SHEET 3 of 3)
MCA160.1	C-41E	DISPOSAL AREA ROAD CROSS SECTIONS (SHEET 1 of 4)
MCA160.1	C-41F	DISPOSAL AREA ROAD CROSS SECTIONS (SHEET 2 of 4)
MCA160.1	C-41G	DISPOSAL AREA ROAD CROSS SECTIONS (SHEET 3 of 4)
MCA160.1	C-41H	DISPOSAL AREA ROAD CROSS SECTIONS (SHEET 4 of 4)
MCA160.1	C-41I	NOT USED
MCA160.1	C-42	TYPICAL SECTIONS AND DETAILS (SHEET 1 of 2)
MCA160.1	C-43	TYPICAL SECTIONS AND DETAILS (SHEET 2 of 2)
MCA160.1	C-44	FENCE DETAILS
MCA160.1	C-44A	GATE DETAILS
MCA160.1	C-44B	WATER DISTRIBUTION PLAN (SHEET 1 OF 2)
MCA160.1	C-44C	WATER DISTRIBUTION PLAN (SHEET 2 OF 2)
MCA160.1	C-44D	WATER DISTRIBUTION DETAILS
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	ACCESS ROADS	
MCA160.1	C-45	NOT USED
MCA160.1	C-46	OVERALL ACCESS ROAD PLAN
MCA160.1	C-47	PLAN SHEET-1
MCA160.1	C-48	PLAN SHEET-2
MCA160.1	C-49	PLAN SHEET-3
MCA160.1	C-50	PLAN SHEET-4
MCA160.1	C-51	PLAN SHEET-5
MCA160.1	C-52	TYPICAL SECTIONS
MCA160.1	C-53	TYPICAL SECTIONS
MCA160.1	C-54	27th STREET PROFILE STA. 6+50 TO STA. 24+00
MCA160.1	C-55	27th STREET PROFILE STA. 24+00 TO STA. 34+00

MCA160.1	C-56	MARINE & 27TH STREET PROFILES
MCA160.1	C-57	McALPINE LOCK ROAD PROFILE
MCA160.1	C-58	27th STREET CROSS SECTIONS
MCA160.1	C-59	27th STREET CROSS SECTIONS
MCA160.1	C-60	MARINE STREET CROSS SECTIONS
MCA160.1	C-61	MARINE STREET CROSS SECTIONS
MCA160.1	C-62	McALPINE LOCK ROAD CROSS SECTIONS
MCA160.1	C-63	McALPINE LOCK ROAD CROSS SECTIONS
MCA160.1	C-64	INTERSECTION DETAILS
MCA160.1	C-65	INTERSECTION DETAILS
MCA160.1	C-66	INTERSECTION DETAILS
MCA160.1	C-67	NOT USED
MCA160.1	C-68	NOT USED
MCA160.1	C-69	NOT USED
MCA160.1	C-70	NOT USED
MCA160.1	C-71	NOT USED
MCA160.1	C-72	TRAFFIC CONTROL
MCA160.1	C-73	TRAFFIC CONTROL
MCA160.1	C-74	TRAFFIC CONTROL
MCA160.1	C-75	TRAFFIC CONTROL
MCA160.1	C-76	TRAFFIC CONTROL
MCA160.1	C-77	**SECURITY GATE DETAILS**
MCA160.1	C-78	NOT USED
MCA160.1	C-79	NOT USED
MCA160.1	C-80	NOT USED
MCA160.1	C-81	NOT USED

***1**

BRIDGE & ROAD ELECTRICAL

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MCA160.1	E-2	LIGHTING PLANS SHEET 2
MCA160.1	E-3	LIGHTING PLANS SHEET 3
MCA160.1	E-4	LIGHTING PLANS SHEET 4
MCA160.1	E-5	LIGHTING PLANS SHEET 5
MCA160.1	E-6	LIGHTING PLANS SHEET 6
MCA160.1	E-7	LIGHTING FIXTURES
MCA160.1	E-8	UTILITY POLE DETAILS
MCA160.1	E-8A	FOUNDATION AND TRENCH DETAILS
MCA160.1	E-8B	POLE WIRING 1
MCA160.1	E-8C	PULL BOX DETAILS 1
MCA160.1	E-8D	ELECTRICAL DETAILS 1
MCA160.2	E-8E	STRUCTURE CONDUIT DETAILS 1
MCA160.3	E-8F	ELECTRICAL DETAILS 2

SITE STRUCTURAL

MCA160.1	S-1	RETAINING & CUTOFF WALLS - PLAN, SECTION & ELEVATIONS
MCA160.1	S-1A	CUTOFF WALLS - PLAN, SECTIONS & ELEVATIONS
MCA160.1	S-1B	CUTOFF WALLS - PLAN, SECTIONS & ELEVATION
MCA160.1	S-2	RETAINING WALL - CONCRETE & REINFORCEMENT DETAILS
MCA160.1	S-3	NOT USED
MCA160.1	S-4	DRAINAGE CULVERT - PLAN & ELEVATIONS
MCA160.1	S-5	NOT USED
MCA160.1	S-6	DRAINAGE CULVERT - PRECAST CULVERT DETAILS
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MCA160.1	S-8	TRASHRACK & DETAILS
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	SITE ELECTRICAL	
MCA160.1	E-9	ELECTRICAL SITE PLAN (SHEET 1 0F 2)
MCA160.1	E-10	ELECTRICAL SITE PLAN (SHEET 2 0F 2)
MCA160.1	E-11	ELECTRICAL SITE DETAILS
MCA160.1	E-12	ELECTRICAL DEMOLITION
MCA160.1	E-13	ELECTRICAL DEMOLITION
MCA160.1	E-13A	ELECTRICAL DEMOLITION
MCA160.1	E-13B	ELECTRICAL DEMOLITION
MCA160.1	E-13C	**ELECTRICAL DEMOLITION & MISCELLANEOUS PLANS**
MCA160.1	E-14	**TRANSFORMER VAULT DETAILS**
MCA160.1	E-14A	**GATE CONTROL SYSTEM**
	LOCK	
MCA200.1	S-9	PLAN - LOCK MONOLITHS, SILLS AND DIFFUSERS
MCA200.1	S-9A	ENLARGED PLAN-LOCK MONOLITHS, SILLS AND DIFFUSERS
MCA200.1	S-9B	ENLARGED PLAN-LOCK MONOLITHS, SILLS AND DIFFUSERS
MCA200.1	S-10	ELEVATION NORTH WALL
MCA200.1	S-11	ELEVATION SOUTH WALL
MCA200.1	S-12	GENERAL NOTES & REINFORCEMENT DETAILS
MCA200.1	S-13	GENERAL NOTES & REINFORCEMENT DETAILS
MCA200.1	S-14	**TYPICAL MASS CONCRETE JOINT DETAILS**
MCA200.1	S-14A	600' LOCK EXPANSION JOINT DETAILS
MCA200.1	S-15	**WATERSTOP DETAILS FOR MASS CONCRETE MONOLITHS**
MCA200.1	S-15A	NORTH WALL WATERSTOP DETAILS
MCA200.1	S-15B	SOUTH WALL WATERSTOP DETAILS
	MASS CONCRETE MONOLITHS	***1**
	MONOLITH SM-1	
MCA200.1	S-16	PLAN AND ELEVATIONS
MCA200.1	S-17	NOT USED
MCA200.1	S-18	NOT USED
MCA200.1	S-19	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-20	NOT USED
MCA200.1	S-21	NOT USED
	MONOLITH SM-2	
MCA200.1	S-22	PLAN AND ELEVATIONS
MCA200.1	S-23	NOT USED
MCA200.1	S-24	NOT USED
MCA200.1	S-25	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-26	NOT USED
MCA200.1	S-27	NOT USED
	MONOLITH SM-3	
MCA200.1	S-28	PLAN AND ELEVATIONS
MCA200.1	S-29	SECTIONAL ELEVATIONS
MCA200.1	S-30	MISCELLANEOUS DETAILS
MCA200.1	S-31	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-32	REINFORCING DETAILS
MCA200.1	S-33	NOT USED

	MONOLITH SM-4	
MCA200.1	S-34	PLAN AND ELEVATIONS
MCA200.1	S-35	NOT USED
MCA200.1	S-36	MISCELLANEOUS DETAILS
MCA200.1	S-37	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-38	NOT USED
MCA200.1	S-39	NOT USED
	MONOLITH SM-5	
MCA200.1	S-40	PLAN AND ELEVATIONS
MCA200.1	S-41	NOT USED
MCA200.1	S-42	NOT USED
MCA200.1	S-43	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-44	NOT USED
MCA200.1	S-45	NOT USED
	MONOLITH SM-6	
MCA200.1	S-46	PLAN AND ELEVATIONS
MCA200.1	S-47	SECTIONAL ELEVATIONS
MCA200.1	S-48	MISCELLANEOUS DETAILS
MCA200.1	S-49	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-50	REINFORCING DETAILS
MCA200.1	S-51	MONOLITH SM6,SM7, & SM21 REINFORCING DETAILS
	MONOLITH SM-7	
MCA200.1	S-52	PLAN AND ELEVATIONS
MCA200.1	S-53	SECTIONAL ELEVATIONS
MCA200.1	S-54	NOT USED
MCA200.1	S-55	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-56	REINFORCING DETAILS
MCA200.1	S-57	REINFORCING DETAILS
	MONOLITH L-1	
MCA200.1	S-58	PLAN AND ELEVATIONS
MCA200.1	S-59	NOT USED
MCA200.1	S-60	NOT USED
MCA200.1	S-61	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-62	NOT USED
MCA200.1	S-63	NOT USED
	MONOLITH L-2	
MCA200.1	S-64	PLAN AND ELEVATIONS
MCA200.1	S-65	SECTIONAL ELEVATIONS
MCA200.1	S-66	MISCELLANEOUS DETAILS
MCA200.1	S-67	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-68	NOT USED
MCA200.1	S-69	NOT USED
	MONOLITH L-3	
MCA200.1	S-70	PLAN AND ELEVATIONS
MCA200.1	S-71	NOT USED
MCA200.1	S-72	MISCELLANEOUS DETAILS
MCA200.1	S-73	REINFORCING PLAN & ELEVATIONS

MCA200.1	S-74	NOT USED
MCA200.1	S-75	NOT USED
	MONOLITH L-4	
MCA200.1	S-76	PLAN AND ELEVATIONS
MCA200.1	S-77	NOT USED
MCA200.1	S-78	NOT USED
MCA200.1	S-79	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-80	NOT USED
MCA200.1	S-81	NOT USED
	MONOLITH SM-18	
MCA200.1	S-82	PLAN AND ELEVATIONS
MCA200.1	S-83	SECTIONAL ELEVATIONS
MCA200.1	S-84	MISCELLANEOUS DETAILS
MCA200.1	S-85	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-86	REINFORCING DETAILS
MCA200.1	S-87	STAIR DETAILS
	MONOLITH SM-19	
MCA200.1	S-88	PLAN AND ELEVATIONS
MCA200.1	S-89	SECTIONAL ELEVATIONS
MCA200.1	S-90	MISCELLANEOUS DETAILS
MCA200.1	S-91	REINFORCING PLAN & SECTIONS
MCA200.1	S-92	REINFORCING DETAILS
MCA200.1	S-93	REINFORCING DETAILS
	MONOLITH SM-20	
MCA200.1	S-94	PLAN AND ELEVATIONS
MCA200.1	S-95	SECTIONAL ELEVATIONS
MCA200.1	S-96	NOT USED
MCA200.1	S-97	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-98	REINFORCING DETAILS
MCA200.1	S-99	NOT USED
	MONOLITH SM-21	
MCA200.1	S-100	PLAN AND ELEVATIONS
MCA200.1	S-101	SECTIONAL ELEVATIONS
MCA200.1	S-102	MESCELLANEOUS DETAILS
MCA200.1	S-103	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-104	REINFORCING DETAILS
MCA200.1	S-105	REINFORCING DETAILS
	MONOLITH SM-22	
MCA200.1	S-106	PLAN AND ELEVATIONS
MCA200.1	S-107	SECTIONAL ELEVATIONS
MCA200.1	S-108	NOT USED
MCA200.1	S-109	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-110	BRIDGE PIER REINFORCING
MCA200.1	S-111	NOT USED
	MONOLITH SM-23	
MCA200.1	S-112	PLAN AND ELEVATIONS
MCA200.1	S-113	SECTIONAL ELEVATIONS

MCA200.1	S-113A	INTAKE SECTION AND DETAILS
MCA200.1	S-114	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-115	REINFORCING DETAILS
MCA200.1	S-116	NOT USED
MCA200.1	S-117	INTAKE DETAILS
MCA200.1	S-118	ROOF EXTENSION DETAILS
	MONOLITH L-16	
MCA200.1	S-119	PLAN AND ELEVATIONS
MCA200.1	S-120	SECTIONAL ELEVATIONS
MCA200.1	S-121	MISCELLANEOUS DETAILS
MCA200.1	S-122	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-123	REINFORCING DETAILS
MCA200.1	S-124	NOT USED
	MONOLITH L-17	
MCA200.1	S-125	PLAN AND ELEVATIONS
MCA200.1	S-126	SECTIONAL ELEVATIONS
MCA200.1	S-127	MISCELLANEOUS DETAILS
MCA200.1	S-128	REINFORCING PLAN & SECTION
MCA200.1	S-129	REINFORCING PLAN & SECTIONS
MCA200.1	S-130	NOT USED
	MONOLITH L-18	
MCA200.1	S-131	PLAN AND ELEVATIONS
MCA200.1	S-132	SECTIONAL ELEVATIONS
MCA200.1	S-133	NOT USED
MCA200.1	S-134	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-135	REINFORCING DETAILS
MCA200.1	S-136	NOT USED
	MONOLITH L-19	
MCA200.1	S-137	PLAN AND ELEVATIONS
MCA200.1	S-138	SECTIONAL ELEVATIONS
MCA200.1	S-139	NOT USED
MCA200.1	S-140	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-141	NOT USED
MCA200.1	S-142	NOT USED
	MONOLITH L-20	
MCA200.1	S-143	PLAN AND ELEVATIONS
MCA200.1	S-144	SECTIONAL ELEVATIONS
MCA200.1	S-145	NOT USED
MCA200.1	S-146	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-147	BRIDGE PIER REINFORCING
MCA200.1	S-148	NOT USED
	MONOLITH L-21	
MCA200.1	S-149	PLAN AND ELEVATIONS
MCA200.1	S-150	SECTIONAL ELEVATIONS
MCA200.1	S-151	NOT USED
MCA200.1	S-152	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-153	NOT USED
MCA200.1	S-154	NOT USED

	MONOLITH L-22	
MCA200.1	S-155	PLAN AND ELEVATIONS
MCA200.1	S-156	SECTIONAL ELEVATIONS
MCA200.1	S-157	NOT USED
MCA200.1	S-158	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-159	NOT USED
MCA200.1	S-160	NOT USED
	MONOLITH L-23	
MCA200.1	S-161	PLAN AND ELEVATIONS
MCA200.1	S-162	SECTIONAL ELEVATIONS
MCA200.1	S-163	NOT USED
MCA200.1	S-164	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-165	NOT USED
MCA200.1	S-166	NOT USED
	MONOLITH L-24	
MCA200.1	S-167	PLAN AND ELEVATIONS
MCA200.1	S-168	SECTIONAL ELEVATIONS
MCA200.1	S-169	INTAKE DETAILS
MCA200.1	S-170	REINFORCING PLAN & ELEVATIONS
MCA200.1	S-171	NOT USED
MCA200.1	S-172	NOT USED
MCA200.1	S-173	NOT USED
	MONOLITH L-25	
MCA200.1	S-174	PLAN AND ELEVATIONS
MCA200.1	S-175	SECTIONAL ELEVATIONS
MCA200.1	S-176	INTAKE DETAILS
MCA200.1	S-177	REINFORCING PLAN & ELEVATIONS
***3 *1**		
	MONOLITH M31 & M32	
MCA200.1	**S-177A**	**STABILIZATION OF M31 & M32**
MCA200.1	**S-177B**	**STABILIZATION OF M31 & M32**
MCA200.1	**S-177C**	**ROCK ANCHORAGE - LOAD TRANSFER SYSTEM**
MCA200.1	**S-177D**	**SHORING PLAN AND SECTIONS**
		***1 *3**
	MANHOLE BULKHEADS	
MCA200.1	S-178	TRENCH BULKHEAD DETAILS
MCA200.1	S-179	TRENCH BULKHEAD DETAILS
MCA200.1	S-180	TRENCH BULKHEAD DETAILS
MCA200.1	S-180A	TRENCH BULKHEAD DETAILS
	ROLLER COMPACTED CONCRETE MONOLITHS	
MCA200.1	S-181	RCC WALLS PLAN & ELEVATIONS
MCA200.1	S-182	RCC WALLS SECTIONAL ELEVATIONS
MCA200.1	S-183	MONOLITH SM-8 PLAN AND ELEVATIONS
MCA200.1	S-184	MONOLITH SM-9 PLAN AND ELEVATIONS
MCA200.1	S-185	MONOLITH SM-10 PLAN AND ELEVATIONS
MCA200.1	S-186	MONOLITH SM-11 PLAN AND ELEVATIONS
MCA200.1	S-187	MONOLITH SM-12 PLAN AND ELEVATIONS
MCA200.1	S-188	MONOLITH SM-13 PLAN AND ELEVATIONS
MCA200.1	S-189	MONOLITH SM-14 PLAN AND ELEVATIONS

MCA200.1	S-190	MONOLITH SM-15 PLAN AND ELEVATIONS
MCA200.1	S-191	MONOLITH SM-16 PLAN AND ELEVATIONS
MCA200.1	S-192	MONOLITH SM-17 PLAN AND ELEVATIONS
MCA200.1	S-193	MONOLITH L-5 PLAN AND ELEVATIONS
MCA200.1	S-194	MONOLITH L-6 PLAN AND ELEVATIONS
MCA200.1	S-195	MONOLITH L-7 PLAN AND ELEVATIONS
MCA200.1	S-196	MONOLITH L-8 PLAN AND ELEVATIONS
MCA200.1	S-197	MONOLITH L-9 PLAN AND ELEVATIONS
MCA200.1	S-198	MONOLITH L-10 PLAN AND ELEVATIONS
MCA200.1	S-199	MONOLITH L-11 PLAN AND ELEVATIONS
MCA200.1	S-200	MONOLITH L-12 PLAN AND ELEVATIONS
MCA200.1	S-201	MONOLITH L-13 PLAN AND ELEVATIONS
MCA200.1	S-202	MONOLITH L-14 PLAN AND ELEVATIONS
MCA200.1	S-203	MONOLITH L-15 PLAN AND ELEVATIONS
MCA200.1	S-204	HIGH MAST LIGHTING SUPPORT DETAILS
MCA200.1	S-205	UTILITY TRENCH REINFORCEMENT DETAILS
MCA200.1	S-206	RCC MONOLITH LIFT DETAILS
MCA200.1	S-207	RCC PLACEMENT PROCEDURE
MCA200.1	S-208	RCC PROCEDURE SEQUENCE
MCA200.1	S-209	WATER STOP & JOINT DETAILS FOR RCC MONOLITHS
MCA200.1	S-210	INTERFACE DETAILS FOR RCC MONOLITHS
MCA200.1	S-211	WALL ARMOR DETAILS FOR RCC MONOLITHS
	SILLS	
MCA200.1	S-212	U/S MITER GATE SILLS - PLAN
MCA200.1	S-212A	D/S MITER GATE SILLS - PLAN AND SECTION
MCA200.1	S-213	U/S & D/S BULKHEAD SILL STEEL REINFORCEMENT
MCA200.1	S-214	MITER GATE SILLS -EMBEDDED METALS
MCA200.1	S-214A	MITER GATE SILL PLAN-EMBEDDED METALS
MCA200.1	S-215	NOT USED
MCA200.1	S-216	NOT USED
	FILLING AND EMPTYING SYSTEM	
MCA200.1	S-217	LOCK PLAN WITH CULVERTS
MCA200.1	S-218	PROFILE AT CENTERLINE LOCK
MCA200.1	S-219	ENLARGED PARTIAL PLAN
MCA200.1	S-220	ENLARGED PARTIAL PLAN
MCA200.1	S-221	ENLARGED PARTIAL PLAN
MCA200.1	S-222	ENLARGED PARTIAL PLAN
MCA200.1	S-223	CULVERTS - SECTIONS AND DETAILS
MCA200.1	S-224	CULVERTS - SECTIONS AND DETAILS
MCA200.1	S-225	CULVERTS - BAFFLES AND PORT EXTENSIONS
MCA200.1	S-226	CULVERTS - REINFORCING SECTIONS AND DETAILS
MCA200.1	S-227	CULVERTS - REINFORCING SECTIONS AND DETAILS
MCA200.1	S-228	CULVERTS - JOINT DETAILS
MCA200.1	S-229	NOT USED
MCA200.1	S-230	NOT USED
MCA200.1	S-231	OUTLET DIFFUSER - PLAN AND SECTIONS
MCA200.1	S-232	OUTLET DIFFUSER - SECTIONS AND DETAILS
MCA200.1	S-233	NOT USED
MCA200.1	S-234	OUTLET DIFFUSER - REINFORCING SECTIONS AND DETAILS
MCA200.1	S-235	OUTLET DIFFUSER - REINFORCING SECTIONS AND DETAILS

VOLUME 2 CULVERT VALVES,

MITER GATES,MECHANICAL AND ELECTRICAL SYSTEMS,
APPROACH WALLS,SERVICE BUILDINGS,ACCESS BRIDGE,
OVERLOOK,VISITORS AREA AND MISCELLANEOUS METALS

MCA450.1 X-1A COVER SHEET VOLUME 2

LOCK MECHANICAL SYSTEMS

MCA200.1	M-1	HYDRAULIC AND UTILITY PIPING
MCA200.1	M-2	HYDRAULIC AND UTILITY PIPING
MCA200.1	M-3	HYDRAULIC AND UTILITY PIPING DETAILS AND SECTIONS
MCA200.1	M-4	HYDRAULIC AND UTILITY PIPING DETAILS AND SECTIONS
MCA200.1	M-5	HYDRAULIC AND UTILITY PIPING DETAILS AND SECTIONS
MCA200.1	M-6	HYDRAULIC AND UTILITY PIPING DETAILS AND SECTIONS
MCA200.1	M-7	HYDRAULIC AND UTILITY PIPING DETAILS AND SECTIONS
MCA200.1	M-8	HYDRAULIC AND UTILITY PIPING DETAILS AND SECTIONS
MCA200.1	M-9	MANHOLE ELEVATIONS
MCA200.1	M-10	MANHOLE ELEVATIONS
MCA200.1	M-11	MANHOLE ELEVATIONS
MCA200.1	M-12	MANHOLE ELEVATIONS
MCA200.1	M-13	MANHOLE ELEVATIONS
MCA200.1	M-14	MANHOLE ELEVATIONS
MCA200.1	M-15	MANHOLE ELEVATIONS
MCA200.1	M-16	MANHOLE PLANS
MCA200.1	M-17	MANHOLE PLANS
MCA200.1	M-18	MANHOLE PLANS
MCA200.1	M-19	MANHOLE PLANS
MCA200.1	M-19A	MISCELLANEOUS MANHOLE DETAILS
MCA200.1	M-20	AIR, AND WATER OUTLET DETAIL
MCA200.1	M-21	ESPLANADE WATER AND SEWAGE PIPING

INSTRUMENTATION

MCA440.1	I-1	GENERAL PLAN SHEET 1 OF 2
MCA440.1	I-2	GENERAL PLAN SHEET 2 OF 2
MCA440.1	I-3	STRAIN GAUGE/THERMISTORS PLACEMENT SM-2
MCA440.1	I-4	STRAIN GAUGE/THERMISTORS PRESSURE CELL PLACEMENT L-11
MCA440.1	I-5	STRAIN GAUGE/THERMISTORS PRESSURE CELL PLACEMENT SM-15
MCA440.1	I-6	STRAIN GAUGE/THERMISTORS PRESSURE CELL PLACEMENT L-22
MCA440.1	I-7	MOVEMENT PINS - DETAILS
MCA440.1	I-8	OPEN STAND PIPE PIEZOMETERS - DETAILS
MCA440.1	I-9	VIBRATING WIRE/THERMISTOR DETAILS
MCA440.1	I-10	LOAD CELL DETAIL
MCA440.1	I-11	PRESSURE CELL DETAILS
MCA440.1	I-12	AUTOMATED DATA ACQUISITION SYSTEM - SCHEMATIC

LOCK ELECTRICAL SYSTEMS

MCA200.1	E-15	480 VOLT CABLE ROUTING(SHEET 1 OF 2)
MCA200.1	E-15A	480 VOLT CABLE ROUTING(SHEET 2 OF 2)
MCA200.1	E-16	120 VOLT CABLE ROUTING

MCA200.1	E-17	DATA CABLE ROUTING
MCA200.1	E-18	CABLE SCHEDULE
MCA200.1	E-19	CABLE SCHEDULE
MCA200.1	E-19A	CABLE SCHEDULE
MCA200.1	E-19B	CABLE SCHEDULE
MCA200.1	E-20	ONE LINE DIAGRAM
MCA200.1	E-21	ONE LINE DIAGRAM
MCA200.1	E-22	TRENCH LAYOUT (SH. 1 OF 4)
MCA200.1	E-22A	TRENCH LAYOUT (SH. 2 OF 4)
MCA200.1	E-23	TRENCH LAYOUT (SH. 3 OF 4)
MCA200.1	E-23A	TRENCH LAYOUT (SH. 4 OF 4)
MCA200.1	E-24	MONOLITH ELECTRICAL DETAILS
MCA200.1	E-25	MONOLITH ELECTRICAL DETAILS
MCA200.1	E-26	MONOLITH ELECTRICAL DETAILS
MCA200.1	E-27	MONOLITH ELECTRICAL DETAILS
MCA200.1	E-28	MONOLITH ELECTRICAL DETAILS
MCA200.1	E-29	MONOLITH ELECTRICAL DETAILS
MCA200.1	E-30	GROUNDING PLAN
	LOCK LIGHTING	
MCA200.1	E-31	LOCK CHAMBER LIGHTING PLAN
MCA200.1	E-32	AIMING CHART AND LIGHTING PLAN
MCA200.1	E-33	APPROACH WALL LIGHTING DETAILS
MCA200.1	E-34	FIXTURE AND POLE SCHEDULE
MCA200.1	E-35	HIGH MAST LIGHTING DETAILS
MCA200.1	E-36	LIGHTING DETAILS
MCA200.1	E-37	NOT USED
	U.S. APPROACH WALL	
MCA210.1	S-236	ALT. 1 PLAN AND ELEVATION
MCA210.1	S-237	ALT. 1 INTERIOR PIERS, PIER CAPS, BUTTRESS
MCA210.1	S-237A	ALT. 1 INTERIOR PIERS - PIER CAP FORM - PLAN & ELEVATION
MCA210.1	S-237B	ALT. 1 PIER CAP FORM - DETAILS
MCA210.1	S-237C	ALT. 1 INTERIOR PIERS - REINFORCING DETAILS
MCA210.1	S-237D	ALT. 1 PIER CAP - REINFORCING STEEL
MCA210.1	S-237E	ALT. 1 PIER CAP - REINFORCING STEEL
MCA210.1	S-237F	ALT. 2 PLAN AND ELEVATION
MCA210.1	S-237G	ALT. 2 INTERIOR PIERS, BUTTRESS
MCA210.1	S-237H	ALT. 2 INTERIOR PIERS REINFORCING DETAILS
MCA210.1	S-237I	ALT. 2 SHEET PILE CELL
MCA210.1	S-238	END CELL
MCA210.1	S-238B	PRECAST CONCRETE BEAMS - LONGITUDINAL PLAN & SECTIONS
MCA210.1	S-238C	PRECAST CONCRETE BEAMS - SECTIONS
MCA210.1	S-238D	PRECAST CONCRETE BEAMS - END ELEVATION AND PLAN
MCA210.1	S-238E	LADDER DETAILS
	D.S. APPROACH WALL	
MCA210.1	S-239	ALT. 1 PLAN & ELEVATION
MCA210.1	S-239B	ALT. 1 INTERIOR PIERS, PIER CAPS BUTTRESS
MCA210.1	S-239C	ALT. 1 INTERIOR PIERS, PIER CAP FORM - PLAN &

ELEVATION

MCA210.1	S-239E	ALT. 1 PIER CAP FORM - DETAILS
MCA210.1	S-239F	ALT. 1 INTERIOR PIERS - REINFORCING DETAILS
MCA210.1	S-239G	ALT. 1 INTERIOR PIERS - REINFORCING DETAILS
MCA210.1	S-239H	ALT. 1 PIER CAP - REINFORCING STEEL
MCA210.1	S-239I	ALT. 1 PIER CAP - REINFORCING STEEL
MCA210.1	S-239J	ALT. 2 PLAN AND ELEVATION
MCA210.1	S-239K	ALT. 2 INTERIOR PIERS, BUTTRESS
MCA210.1	S-239L	ALT. 2 INTERIOR PIERS REINFORCING DETAILS
MCA210.1	S-239M	ALT. 2 INTERIOR PIERS REINFORCING DETAILS
MCA210.1	S-239N	ALT. 2 SHEET PILE CELL
MCA210.1	S-240	NOT USED
MCA210.1	S-241	END CELL
MCA210.1	S-242	PRECAST CONCRETE BEAMS - LONGITUDINAL PLAN & SECTIONS
MCA210.1	S-242A	PRECAST CONCRETE BEAMS - SECTIONS
MCA210.1	S-242B	PRECAST CONCRETE BEAMS - END ELEVATION AND PLAN

APPROACH WALL

MCA210.1	S-245	NOT USED
MCA210.1	S-246	UPSTREAM ALT. 1 CONSTRUCTION SEQUENCE
MCA210.1	S-246A	DOWNSTREAM ALT. 1 CONSTRUCTION SEQUENCE
MCA210.1	S-247	ALT. 1 CONSTRUCTION SEQUENCE
MCA210.1	S-247A	ALT. 1 SEAL COLLAR DETAILS
MCA210.1	S-247B	ALT. 2 CONSTRUCTION SEQUENCE
MCA210.1	S-248	NOT USED

CULVERT VALVE AND BULKHEAD

CULVERT VALVE

MCA220.1	S-249	ARRANGEMENT
MCA220.1	S-250	TRUNNION ANCHORAGE
MCA220.1	S-251	TRUNNION BEAM & DETAILS
MCA220.1	S-252	ELEVATION, SECTIONS & DETAILS
MCA220.1	S-253	TRUNNION BEARING DETAILS
MCA220.1	S-254	SKIN PLATE & DETAILS
MCA220.1	S-255	SEALS AND CLAMPING BAR
MCA220.1	S-256	NOT USED
MCA220.1	S-257	NOT USED
MCA220.1	S-258	SIDE, TOP & BOTTOM SEALS & ANCHORAGES
MCA220.1	S-258A	NOT USED
MCA220.1	S-259	EMBEDDED METALS
MCA220.1	S-260	NOT USED
MCA220.1	E-38	CATHODIC PROTECTION
MCA220.1	M-22	CULVERT VALVE MACHINERY ASSEMBLY
MCA220.1	M-23	CULVERT VALVE MACHINERY DETAILS
MCA220.1	M-24	CULVERT VALVE MACHINERY DETAILS

CULVERT BULKHEAD

MCA220.1	S-261	PLAN , ELEVATION AND DETAILS
MCA220.1	S-262	DETAILS
MCA220.1	S-263	PICKUP FRAME AND DETAILS
MCA220.1	S-264	BULKHEAD RECESSES - EMBEDDED METALS

MCA220.1	S-265	BULKHEAD RECESS DETAILS
MCA220.1	S-265A	NOT USED
	SEALING DIAPHRAGM	
MCA220.1	S-266	SEALING DIAPHRAGM & EMBEDDED METALS
MCA220.1	S-267	JACKING ASSEMBLY/PLATES
	INTAKE SCREENS	
MCA220.1	S-268	INTAKE SCREENS & LIFTING ASSEMBLY - SM23
MCA220.1	S-268A	INTAKE SCREENS & LIFTING ASSEMBLY - L24 & L25
MCA220.1	S-268B	INTAKE SCREENS & LIFTING ASSEMBLY DETAILS
MCA220.1	S-269	SOUTH WALL SCREEN GUIDES- PLAN & DETAILS
MCA220.1	S-270	SOUTH WALL SCREEN GUIDES- SECTIONS & DETAILS
MCA220.1	S-271	SOUTH WALL SCREEN GUIDES- SECTIONS & DETAILS
MCA220.1	S-272	NOT USED
MCA220.1	S-273	NORTH WALL SCREEN GUIDES - PLAN & DETAILS
MCA220.1	S-274	NORTH WALL SCREEN GUIDES - SECTIONS & DETAILS
MCA220.1	S-275	NOT USED
	MITER GATES	
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MCA230.1	S-276	DESIGN CRITERIA
MCA230.1	S-276A	OUTLINE AND RECESS
MCA230.1	S-277	DOWNSTREAM ELEVATION
MCA230.1	S-278	UPSTREAM ELEVATION
MCA230.1	S-279	TOP GIRDER PLAN
MCA230.1	S-280	INTERMEDIATE GIRDER PLAN
MCA230.1	S-281	BOTTOM GIRDER PLAN
MCA230.1	S-282	GIRDER DETAILS (SHEET 1 0f 2)
MCA230.1	S-282A	GIRDER DETAILS (SHEET 2 0f 2)
MCA230.1	S-283	MISCELLANEOUS DETAILS
MCA230.1	S-283A	GATE LIFTER DETAILS
MCA230.1	S-284	CYLINDER CONNECTION DETAILS
MCA230.1	S-285	CYLINDER CONNECTION COMPONENTS
MCA230.1	S-286	INBOARD POSITIVE DIAGONAL ANCHORAGE DETAIL
MCA230.1	S-287	OUTBOARD NEGATIVE DIAGONAL ANCHORAGE DETAIL
MCA230.1	S-288	DIAGONAL DETAILS
MCA230.1	S-289	DIAGONAL PRESTRESSING
MCA230.1	S-290	PINTLE LAYOUT
MCA230.1	S-291	PINTLE BASE
MCA230.1	S-292	NOT USED
MCA230.1	S-293	PINTLE SOCKET DETAILS
MCA230.1	S-294	PINTLE SOCKET
MCA230.1	S-295	SEALS DETAILS (SHEET 1 OF 2)
MCA230.1	S-296	SEAL DETAILS (SHEET 2 OF 2)
MCA230.1	S-297	NOT USED
MCA230.1	S-298	ANCHORAGE ASSEMBLY
MCA230.1	S-299	EMBEDDED ANCHORAGE
MCA230.1	S-300	EMBEDDED ANCHORAGE DETAILS
MCA230.1	S-301	GUDGEON ANCHOR LINKAGE
MCA230.1	S-302	GUDGEON ANCHOR LINKAGE
MCA230.1	S-303	GUDGEON DETAILS
MCA230.1	S-304	ANCHORAGE PARTS LIST AND GENERAL NOTES

MCA230.1	S-305	EMBEDDED WALL QUOIN
MCA230.1	S-306	EMBEDDED WALL QUOIN
MCA230.1	S-307	ADJUSTABLE QUOIN BLOCK ASSEMBLY
MCA230.1	S-308	ADJUSTABLE QUOIN END VIEWS
MCA230.1	S-308A	ADJUSTABLE QUOIN SIDE VIEWS
MCA230.1	S-308B	ADJUSTABLE MITER BLOCK ASSEMBLY
MCA230.1	S-308C	ADJUSTABLE MITER BLOCK END VIEWS
MCA230.1	S-308D	ADJUSTABLE MITER BLOCK SIDE VIEWS
MCA230.1	S-308E	ADJUSTABLE QUOIN & MITER BLOCK PARTS LIST
MCA230.1	S-308F	EMBEDDED WALL QUOIN PARTS LIST
MCA230.1	S-309	FENDER ELEVATIONS
MCA230.1	S-310	FENDER DETAILS (SHEET 1 OF 2)
MCA230.1	S-311	FENDER DETAILS (SHEET 2 OF 2)
MCA230.1	S-312	RECESS LATCH
MCA230.1	S-313	MITER DEVICE AND LATCH
MCA230.1	S-314	MITERING DEVICE DETAILS
MCA230.1	S-315	MITER LATCH DETAILS
MCA230.1	S-316	BRIDGE FRAMING (SHEET 1 of 2)
MCA230.1	S-317	BRIDGE FRAMING (SHEET 2 of 2)
MCA230.1	S-318	BRIDGE GRATING AND GUARDRAILS
MCA230.1	S-319	BRIDGEWAY FRAMING & GUARDRAIL DETAILS
MCA230.1	S-320	GUARDRAIL DETAILS
MCA230.1	S-321	BRIDGEWAY GRATING
MCA230.1	E-39	MITER GATE SWITCH PLAN
MCA230.1	E-40	MITER GATE SWITCH DETAILS
MCA230.1	E-41	MITER GATE SWITCH DETAILS
MCA230.1	E-42	NOT USED
MCA230.1	E-43	NOT USED
MCA230.1	E-44	CATHODIC PROTECTION
MCA230.1	E-45	CATHODIC PROTECTION
MCA230.1	M-25	MITER GATE MACHINERY GENERAL ARRANGEMENT
MCA230.1	M-26	**MITER GATE CYLINDER**
MCA230.1	M-27	GATE LATCHING DEVICE ASSEMBLY
MCA230.1	M-28	GATE LATCHING DEVICE DETAILS
MCA230.1	M-29	GATE LATCHING DEVICE COVER PLATES DETAILS
MCA230.1	M-30	**NOT USED**

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MECHANICAL SYSTEMS

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MCA240.1	M-31	HYDRAULIC SYSTEM SCHEMATIC
MCA240.1	M-32	HYDRAULIC VALVE MANIFOLD DETAILS
MCA240.1	M-33	NOT USED
MCA240.1	M-34	MITER GATE BUBBLER SYSTEM
MCA240.1	M-35	NOT USED
MCA240.1	M-36	HOSE CABINETS
MCA240.1	M-37	**HOSE CABINETS**
MCA240.1	M-38	UTILITY PIPING WET WELL DETAILS
MCA240.1	M-39	UTILITY PIPING WET WELL DETAILS

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ELECTRICAL SYSTEMS

CCTV SYSTEM

MCA250.1	E-46	CCTV SYSTEM BLOCK DIAGRAM
MCA250.1	E-47	CCTV SYSTEM PLAN

	COMMUNICATIONS	
MCA250.1	E-47A	COMMUNICATION DETAILS
MCA250.1	E-47B	COMMUNICATION DETAILS
MCA250.1	E-47C	COMMUNICATION DETAILS
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	CONTROLS	
MCA250.1	E-48	PLC SYMBOLS & ABBREAVIATIONS
MCA250.1	E-49	PLC SYMBOLS & ABBREAVIATIONS
MCA250.1	E-50	COMMUNICATIONS SYSTEMS OVERVIEW
MCA250.1	E-51	PLC CONTROL SYSTEM OVERVIEW
MCA250.1	E-52	REMOTE I/O SYSTEM OVERVIEW
MCA250.1	E-53	MAIN PLC & REMOTE I/O SYSTEM
MCA250.1	E-54	TRAFFIC SIGNAL SCHEMATICS
MCA250.1	E-55	HIGH MAST LIGHTING CONTROL NORTH WALL
MCA250.1	E-56	HIGH MAST LIGHTING CONTROL SOUTH WALL
MCA250.1	E-57	APPROACH WALL LIGHTS
MCA250.1	E-58	DISCHARGE AREA LIGHTS & SIREN
MCA250.1	E-59	SCHEMATICS DOWNSTREAM MITER GATES & CULVERT VALVES
MCA250.1	E-60	SCHEMATICS UPSTREAM MITER GATES & CULVERT VALVES
MCA250.1	E-61	BUBBLER & LIGHTING CONTROL
MCA250.1	E-62	SUMP PUMP CONTROL CIRCUIT
MCA250.1	E-63	PUMP CONTROL
MCA250.1	E-64	PUMP CONTROL
MCA250.1	**E-64A**	**HPU CIRCULATING PUMP CONTROL**
MCA250.1	E-65	WATER LEVEL SENSING SYSTEM
MCA250.1	E-66	SEWAGE & UTILITY PUMP SCHEMATIC
MCA250.1	E-67	GERERATOR AND ATS SCHEMATIC
MCA250.1	E-68	LOCK SENSOR AND LIMIT SWITCH LOCATION PLAN
MCA250.1	E-69	GRAPHIC DISPLAY SYSTEM
MCA250.1	E-70	GRAPHIC DISPLAY SYSTEM
MCA250.1	E-71	MISCELLANEOUS DETAILS
MCA250.1	E-72	MANUAL CONTROLS LADDER DIAGRAM
MCA250.1	E-73	MANUAL CONTROLS LADDER DIAGRAM
MCA250.1	E-74	MANUAL CONTROLS LADDER DIAGRAM
MCA250.1	E-74A	MANUAL CONTROLS LADDER DIAGRAM
MCA250.1	E-74B	MANUAL CONTROLS LADDER DIAGRAM
MCA250.1	E-74C	MANUAL CONTROLS LADDER DIAGRAM
MCA250.1	E-74D	MANUAL CONTROLS LADDER DIAGRAM
MCA250.1	E-74E	MANUAL CONTROLS PANEL LAYOUT & DETAILS
MCA250.1	E-74F	MANUAL CONTROLS LADDER DIAGRAM
MCA250.1	E-74G	MANUAL CONTROLS LADDER DIAGRAM
MCA250.1	E-74H	MANUAL CONTROLS PANEL LAYOUT & DETAILS
MCA250.1	E-74I	MANUAL CONTROLS - D/S MANUAL CONTROL PANEL LAYOUT
MCA250.1	E-74J	MANUAL CONTROLS - RELAY PANEL A LAYOUT
MCA250.1	E-74K	MANUAL CONTROLS - RELAY PANEL C LAYOUT
MCA250.1	E-74L	MANUAL CONTROLS - RELAY PANELS B & D LAYOUT
MCA250.1	E-74M	MANUAL CONTROLS - RELAY PANEL A TERMINAL LAYOUT
MCA250.1	E-74N	MANUAL CONTROLS - RELAY PANEL C TERMINAL LAYOUT
MCA250.1	E-74O	MANUAL CONTROLS - RELAY PANELS B &D TERMINAL LAYOUT
MCA250.1	E-74P	MANUAL CONTROLS - MANUAL CONTROL PANELS TERMINAL LAYOUT
MCA250.1	**E-74Q**	**CULVERT VALVE SENSOR AND SWITCH ASSEMBLY (SHEET 1 OF 4)**

MCA250.1 E-74R CULVERT VALVE SENSOR AND SWITCH ASSEMBLY (SHEET 2 OF 4)
MCA250.1 E-74S CULVERT VALVE SENSOR AND SWITCH ASSEMBLY (SHEET 3 OF 4)
MCA250.1 E-74T CULVERT VALVE SENSOR AND SWITCH ASSEMBLY (SHEET 4 OF 4)

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ACCESS BRIDGE

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MCA380.1	S-322	PLAN & ELEVATION - 1
MCA380.1	S-323	PLAN & ELEVATION - 2
MCA380.1	S-324	PLAN & ELEVATION - 3
MCA380.1	S-325	PLAN & ELEVATION - 4
MCA380.1	S-326	PLAN & ELEVATION - 5
MCA380.1	S-327	GENERAL NOTES
MCA380.1	S-328	ABUTMENT NO. 1 PLAN & ELEVATION
MCA380.1	S-329	ABUTMENT NO. 2 PLAN & ELEVATION
MCA380.1	S-330	ABUTMENT DETAILS
MCA380.1	S-331	WINGWALL ELEVATIONS
MCA380.1	S-332	WINGWALL SECTIONS
MCA380.1	S-333	PIERS 1, 2, 3 DETAILS
MCA380.1	S-334	PIER 4 DETAILS
MCA380.1	S-335	PIER 5, 6, 7 DETAILS
MCA380.1	S-336	PIER 8 DETAILS
MCA380.1	**S-336A**	**PIER 8 DETAILS - 2**
MCA380.1	**S-336B**	**PIER 8 DETAILS - 3**
MCA380.1	S-337	PIER 8 FDN. DETAILS
MCA380.1	**S-337A**	**POWERHOUSE DEMOLITION DETAILS**
MCA380.1	**S-337B**	**POWERHOUSE DEMOLITION DETAILS**
MCA380.1	S-338	PIERS 9 & 13 DETAILS
MCA380.1	S-339	PIERS 10, 11, 12 DETAILS
MCA380.1	S-340	PIERS 9 & 10 FDN. DETAILS
MCA380.1	S-341	PIER 11 FDN. DETAILS
MCA380.1	S-342	PIERS 12 & 13 FDN. DETAILS - 1
MCA380.1	S-342A	PIERS 12 & 13 FDN. DETAILS - 2
MCA380.1	S-343	PIER 14 -17 DETAILS
MCA380.2	S-343A	PIERS 18 & 19 DETAILS
MCA380.1	S-344	FRAMING PLANS SHEET 1
MCA380.1	S-345	FRAMING PLANS SHEET 2
MCA380.1	S-346	FRAMING PLANS SHEET 3
MCA380.1	S-347	FRAMING PLANS SHEET 4
MCA380.1	S-348	FRAMING PLANS SHEET 5
MCA380.1	S-349	DIAPHRAGM DETAILS-1
MCA380.1	S-349A	DIAPHRAGM DETAILS-2
MCA380.1	S-349B	DIAPHRAGM DETAILS-3
MCA380.1	S-350	SUPER STRUCTURE I-BEAM SECTIONS
MCA380.1	S-351	SUPER STRUCTURE BEAM DATA TABLE
MCA380.1	S-352	SUPER STRUCTURE BEAM ELEVATION
MCA380.2	S-352A	SUPER STRUCTURE BEAM NOTES
MCA380.1	S-353	TRANSVERSE SECTIONS - 1
MCA380.1	S-354	TRANSVERSE SECTIONS - 2
MCA380.1	S-355	DECK SLAB REINFORCING PLAN - 1
MCA380.1	S-356	DECK SLAB REINFORCING PLAN - 2
MCA380.1	S-357	DECK SLAB REINFORCING PLAN - 3

MCA380.1 S-358 DECK SLAB REINFORCING PLAN - 4
MCA380.1 S-359 DECK SLAB REINFORCING PLAN - 5
MCA380.1 S-360 CONSTRUCTION ELEVATIONS - 1
MCA380.1 S-361 CONSTRUCTION ELEVATIONS - 2
MCA380.1 S-362 CONSTRUCTION ELEVATIONS - 3
MCA380.2 S-362A CONSTRUCTION ELEVATIONS - 4
MCA380.3 S-362B CONSTRUCTION ELEVATIONS - 5
MCA380.1 S-363 BEARING PAD DETAILS 1
MCA380.1 S-364 BEARING PAD DETAILS 2
MCA380.1 S-365 DECK JOINT DETAILS - 1
MCA380.1 S-366 DECK JOINT DETAILS - 2
MCA380.1 S-367 DRAINAGE DETAILS - 1
MCA380.1 S-368 DRAINAGE DETAILS - 2
MCA380.1 S-369 UTILITY PLANS SHEET 1
MCA380.1 S-369A UTILITY PLANS SHEET 2
MCA380.1 S-370 UTILITY PLANS SHEET 3
MCA380.1 S-371 UTILITY DETAILS - 1
MCA380.1 S-372 UTILITY DETAILS - 2
MCA380.1 S-373 UTILITY DETAILS - 3
MCA380.1 S-374 FENCE / RAIL DETAILS - 1
MCA380.1 S-374A FENCE / RAIL DETAILS - 2
MCA380.1 S-374B FENCE / RAIL DETAILS - 3
MCA380.1 S-374C FENCE / RAIL DETAILS - 4
MCA380.1 S-374D APPROACH SLAB DETAILS

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SERVICE BUILDINGS

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BUILDING A

MCA420.1 A-1 1ST,MEZZANINE, 2ND & 3RD FLOOR PLANS
MCA420.1 A-2 1ST, 2ND, 3RD & MEZZANINE FLOOR REFLECTED CEILING PLANS & ROOF PLAN
MCA420.1 A-3 BUILDING ELEVATIONS
MCA420.1 A-4 BUILDING SECTIONS
MCA420.1 A-5 WALL SECTIONS
MCA420.1 A-6 WALL SECTIONS AND DETAILS
MCA420.1 A-7 DOOR & WINDOW DETAILS
MCA420.1 A-8 ROOM FINISH SCHEDULE & INTERIOR SECTIONS & ELEVATIONS
MCA420.1 A-9 STAIR SECTIONS AND DETAILS
MCA420.1 A-10 MISCELLANEOUS DETAILS
MCA420.1 A-10A MISCELLANEOUS DETAILS
MCA420.1 A-10B MISCELLANEOUS DETAILS
MCA420.1 A-10C SIGNAGE SCHEDULE AND DETAILS
MCA420.1 LS-1 LIFE SAFETY/FIRE PROTECTION CODE REVIEW
MCA420.1 LS-2 LIFE SAFETY/FIRE PROTECTION FLOOR PLANS
MCA420.1 S-375 STRUCTURAL NOTES BLDG. A,B,C & D
MCA420.1 S-376 FLOOR PLANS
MCA420.1 S-377 ROOF FRAMING PLAN
MCA420.1 S-378 ELEVATIONS
MCA420.1 S-379 WALL SECTIONS
MCA420.1 S-380 CANOPY ROOF FRAMING PLAN
MCA420.1 S-380A SECTIONS & DETAILS
MCA420.1 S-380B SECTIONS & DETAILS
MCA420.1 E-75 LIGHTING PLANS

MCA420.1	E-76	POWER PLANS
MCA420.1	E-76A	ENLARGED PLANS & DETAILS
MCA420.1	E-77	MCC ELEVATIONS & DETAILS
MCA420.1	E-78	LIGHTING DETAILS
MCA420.1	E-79	LIGHTING DETAILS
MCA420.1	E-80	SCHEDULES
MCA420.1	E-81	LIGHTNING PROTECTION PLAN
MCA420.1	E-82	LIGHTNING PROTECTION DETAILS
MCA420.1	M-40	MECHANICAL EQUIPMENT LAYOUT
MCA420.1	M-41	HVAC PLANS
MCA420.1	M-42	HVAC DETAILS
MCA420.1	M-43	PLUMBING AND SANITARY PLANS
MCA420.1	M-44	PLUMBING AND SANITARY DETAILS
MCA420.1	M-45	AIR, RAW WATER & HYD. PLANS & DETAILS
MCA420.1	M-46	AIR, RAW WATER AND HYDRAULIC PIPING
MCA420.1	M-47	NOT USED
MCA420.1	M-48	NOT USED
MCA420.1	M-49	NOT USED
MCA420.1	M-50	NOT USED
MCA420.1	M-51	NOT USED
MCA420.1	M-52	MECHANICAL EQUIPMENT SCHEDULES

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BUILDING B

MCA420.1	A-11	1ST AND 2ND FLOOR PLANS & ROOF PLAN
MCA420.1	A-12	ELEVATIONS
MCA420.1	A-13	BUILDING SECTIONS & DETAILS
MCA420.1	A-13A	WALL SECTIONS & DETAILS
MCA420.1	S-381	1st. & 2nd. FLOOR PLANS & ROOF FRAMING PLAN
MCA420.1	S-381A	ELEVATIONS
MCA420.1	S-381B	WALL SECTIONS
MCA420.1	S-381C	SECTIONS & DETAILS
MCA420.1	S-381D	SECTIONS & DETAILS
MCA420.1	E-83	ELECTRICAL PLANS
MCA420.1	E-84	MCC ELEVATIONS & DETAILS
MCA420.1	E-85	ELECTRICAL PLANS
MCA420.1	E-86	NOT USED
MCA420.1	E-87	SCHEDULES
MCA420.1	E-88	LIGHTNING PROTECTION PLAN
MCA420.1	E-89	LIGHTNING PROTECTION DETAILS
MCA420.1	M-53	MECHANICAL EQUIPMENT LAYOUT
MCA420.1	M-54	AIR, RAW WATER & HYD. PIPING, PLANS & DETAILS
MCA420.1	M-55	AIR, RAW WATER AND HYDRAULIC PIPING
MCA420.1	M-56	VENTILATION PLANS AND DETAILS
MCA420.1	M-57	NOT USED
MCA420.1	M-58	NOT USED
MCA420.1	M-59	MECHANICAL EQUIPMENT SCHEDULE
MCA420.1	M-59A	FUEL OIL STORAGE
MCA420.1	M-59B	GENERATOR DETAILS
MCA420.1	M-59C	GENERATOR DETAILS

BUILDING C

MCA420.1	A-14	FLR PLAN, ROOF PLAN & BLDG SECTIONS
MCA420.1	A-15	ELEVATIONS AND DETAILS
MCA420.1	A-15A	SHIP LADDER AND HORIZONTAL COLD JOINT DETAILS

MCA420.1	A-16	WALL SECTIONS & DETAILS
MCA420.1	S-382	FLOOR PLAN & ROOF FRAMING PLAN
MCA420.1	S-382A	SECTIONS
MCA420.1	S-382B	DETAILS
MCA420.1	E-90	ELECTRICAL PLANS
MCA420.1	E-91	MCC ELEVATIONS & DETAILS
MCA420.1	E-92	NOT USED
MCA420.1	E-93	NOT USED
MCA420.1	E-94	SCHEDULES
MCA420.1	E-95	LIGHTNING PROTECTION PLAN
MCA420.1	E-96	LIGHTNING PROTECTION DETAILS
MCA420.1	M-60	MECHANICAL EQUIPMENT LAYOUT BUILDING "C"
MCA420.1	M-61	HYDRAULIC PIPING, PLANS AND DETAILS
MCA420.1	M-62	NOT USED
MCA420.1	M-63	VENTILATION PLANS AND DETAILS
MCA420.1	M-64	NOT USED
MCA420.1	M-65	NOT USED
MCA420.1	M-66	NOT USED
MCA420.1	M-67	MECHANICAL EQUIPMENT SCHEDULES
	BUILDING D	
MCA420.1	A-17	FLR PLAN, ROOF PLAN & BLDG SECTIONS
MCA420.1	A-18	ELEVATIONS & DETAILS
MCA420.1	A-19	WALL SECTIONS & DETAILS
MCA420.1	S-383	FLOOR PLAN & ROOF FRAMING PLAN
MCA420.1	S-383A	SECTIONS
MCA420.1	S-383B	DETAILS
MCA420.1	E-97	ELECTRICAL PLANS
MCA420.1	E-98	MCC ELEVATIONS & DETAILS
MCA420.1	E-99	NOT USED
MCA420.1	E-100	NOT USED
MCA420.1	E-101	SCHEDULES
MCA420.1	E-102	LIGHTNING PROTECTION PLAN
MCA420.1	E-103	LIGHTNING PROTECTION DETAILS
MCA420.1	M-68	MECHANICAL EQUIPMENT LAYOUT
MCA420.1	M-69	HYDRAULIC PIPING, PLANS AND DETAILS
MCA420.1	M-70	NOT USED
MCA420.1	M-71	VENTILATION PLANS AND DETAILS
MCA420.1	M-72	NOT USED
MCA420.1	M-73	NOT USED
MCA420.1	M-74	MECHANICAL EQUIPMENT SCHEDULES
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	OVERLOOK PAVILION	
MCA420.1	C-82	PLAN AND ELEVATION
MCA420.1	S-383C	PIER DETAILS
MCA420.1	S-383D	PIER DETAILS
MCA420.1	S-383E	DECK SLAB PLAN & REINFORCING
MCA420.1	S-383F	EXPANSION JOINT DETAILS
MCA420.1	S-383G	**RAILING DETAILS**
MCA420.1	S-383H	DECK OVERLAY DETAILS
MCA420.1	S-383I	WALL LAYOUT & DETAILS
MCA420.1	S-383J	CANOPY ROOF FRAMING PLAN
MCA420.1	S-383K	CANOPY ROOF DETAILS
MCA420.1	S-383L	NOT USED

MCA420.1	S-383M	NOT USED
MCA420.1	S-383N	NOT USED
MCA420.1	S-383O	NOT USED
MCA420.1	S-383P	NOT USED
MCA420.1	S-383Q	NOT USED
MCA420.1	S-383R	NOT USED
MCA420.1	E-104	ELECTRICAL PLAN AND DETAILS

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VISITORS AREA AND RIVER WALK

MCA420.1	C-83	SITE PLAN
MCA420.1	C-84	GRADING PLAN
MCA420.1	A-25	PLAN
MCA420.1	A-26	DETAILS
MCA420.1	E-105	PLAN
MCA420.1	E-106	DETAILS

MISCELLANEOUS METALS

MCA440.1	S-384	WALL ARMOR & CORNER PROTECTION
MCA440.1	S-384A	MISCELLANEOUS ARMOR AND CORNER PROTECTION
MCA440.1	S-385	MITER GATE CYLINDER MOUNTING BASE
MCA440.1	S-386	TYPICAL REINFORCING DETAIL - WALL ACCESSORIES
MCA440.1	S-387	LINE HOOK & CHECK POST SECTIONS AND DETAILS
MCA440.1	S-388	LINE HOOK & CHECKPOST REINFORCING DETAILS
MCA440.1	S-389	NOT USED
MCA440.1	S-390	STAFF GAGES DETAILS
MCA440.1	S-391	NOT USED
MCA440.1	S-392	NOT USED
MCA440.1	S-393	LADDER RECESS DETAILS
MCA440.1	S-394	MONOLITH BULKHEAD LADDER DETAILS
MCA440.1	S-395	HANDRAIL DETAILS
MCA440.1	S-396	HANDRAIL DETAILS
MCA440.1	S-397	HANDRAIL DETAILS
MCA440.1	S-398	NOT USED
MCA440.1	S-399	NOT USED
MCA440.1	S-400	TRENCH DETAILS
MCA440.1	S-401	MANHOLE CAP DETAILS
MCA440.1	S-401A	MANHOLE CAP DETAILS
MCA440.1	S-402	MANHOLE CAP DETAILS
MCA440.1	S-403	MISCELLANEOUS RECESS DETAILS
MCA440.1	S-404	NOT USED
MCA440.1	S-405	MAINT. BULKHEAD RECESS DETAILS MONOLITHS L2, L17, SM3, & SM19
MCA440.1	S-406	MAINT. BULKHEAD RECESS DETAILS MONOLITHS L4, L19, SM5, & SM21
MCA440.1	S-407	FLOATING MOORING BITT RECESS ANCHORAGE
MCA440.1	S-408	FLOATING MOORING BITT RECESS DETAILS
MCA440.1	S-409	FLOATING MOORING BITT RECESS GRATING & STOP BEAM

FLOATING MOORING BITTS

MCA440.1	M-75	GENERAL ARRANGEMENT AND DETAILS
MCA440.1	M-76	DETAILS (SHEET 1 OF 2)
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41-131.3/1	12	**NOT USED**
41-131.4/1	13	**NOT USED**
41-131.5/1	14	**NOT USED**
41-131.6/1	15	**NOT USED** ***2**
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MISCELLANEOUS PARTS

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A19242 258 264 FT. SINGLE TRACK R.R. SWING BRIDGE, AT 26TH. STREET
A19243 259 MACHINERY & CENTER GIRDER FOR 26TH. STREET R.R. SWING BRIDGE
A19244 260 DEAD LOAD STRESS DIAGRAM FOR 264' SINGLE TRACK R.R. SWING SWING BRIDGE AT 26TH.
A19245 261 LIVE LOAD STRESSES FOR 26TH. ST. SINGLE TRACK R.R. SWING BRIDGE
A19246 262 LIVE LOAD STRESSES FOR 26TH. ST. SINGLE TRACK R.R. SWING BRIDGE
A19247 263 OPERATOR'S HOUSE FOR 26TH. ST. R.R. SWING BRIDGE
A19297 264 PLAN AND SECTION OF BRIDGE FLOOR
B19191 265 ELEVATIONS FOR 26TH. STREET DRAW BRIDGE
CA-4074 266 GYROL FLUID DRIVE LAYOUT FOR TURN BRIDGE
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CA-4076 268 DETAILS OF SUPPORTS FOR DRIVE, SPEED REDUCERS & BEARINGS
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D-19324 272 PROPOSED COMBINATION HIGHWAY & SINGLE TRACK R.R. SWING BRIDGE OVER LOUISVILLE 7 PORTLAND CANAL LOCK AT 26TH. ST.
SWB1 273 ASSEMBLY & DETAILS OF CHANGES REQUIRED FOR LOCKING DEVICE
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RECONSTRUCTION L & D NO. 41

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OL-132.1/9	296	NEW MOVABLE BRIDGE-BRACING
OL-132.1/10	297	NEW MOVABLE BRIDGE-COUNTERWEIGHT SUPPORTS
OL-132.1/11	298	NEW MOVABLE BRIDGE-OPERATING MACHINERY
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OL-200.1/6	309	MAIN LOCK-LOWER GUARD WALL-MONOLITHSLG-8 THRU LG-14
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OL-200.1/16	316	MAIN LOCK-NORTH WALL-MONOLITHS R27, 28, 29, 30 & 31
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OL-200.1/22	322	MAIN LOCK-NORTH WALL-MONOLITHS R52, 53, 54
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OL-200.1/24	324	MAIN LOCK-NORTH WALL-MONOLITHS R56 THRU R61
OL-200.1/25	325	MAIN LOCK-NORTH WALL-MONOLITHS R62, R63, R64, R65 & R66
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OL-200.1/33	330	MAIN LOCK-NORTH WALL-REINFORCEMENT DETAILS (SHEET NO. 4)
OL-200.1/34	331	MAIN LOCK-NORTH WALL-REINFORCEMENT DETAILS (SHEET NO. 5)
OL-200.1/35	332	MAIN LOCK-NORTH WALL-REINFORCEMENT DETAILS (SHEET NO. 6)
OL-200.1/36	333	MAIN LOCK-NORTH WALL-REINFORCEMENT DETAILS (SHEET NO. 7)
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OL-200.1/38	335	MAIN LOCK-NORTH WALL-REINFORCEMENT DETAILS (SHEET NO. 9)
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OL-200.1/40	337	MAIN LOCK-NORTH WALL-REINFORCEMENT DETAILS (SHEET NO. 11)
OL 200.1/41	338	MAIN LOCK-NORTH WALL-REINFORCEMENT DETAILS (SHEET NO. 12)
OL 200.1/42	339	MAIN LOCK-NORTH WALL-REINFORCEMENT DETAILS (SHEET NO. 13)
OL-200.1/45	340	MAIN LOCK-UPPER GUARD WALL-MONOLITHS UG-1 THRU UG-10
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OL-200.1/54	347	MAIN LOCK-SOUTH WALL-MONOLITHS M14, 15 & 16
OL-200.1/55	348	MAIN LOCK-SOUTH WALL-MONOLITHS M17 & M18 (SHEET 1)
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OL-200.1/58	351	MAIN LOCK-SOUTH WALL-MONOLITHS M19 & M20
OL-200.1/59	352	MAIN LOCK-SOUTH WALL-MONOLITHS M21, M22, M23, M24 & M25
OL-200.1/60	353	MAIN LOCK-SOUTH WALL-MONOLITHS M26, M27, M28 AND M29
OL-200.1/61	354	MAIN LOCK-SOUTH WALL-MONOLITHS M30 & M31
OL-200.1/62	355	MAIN LOCK-SOUTH WALL-EMERGENCY GATE-MONOLITH NO. M32
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OL-200.1/126 393 MAIN LOCK-EMERGENCY GATE RECESS-FIXED METAL DETAILS
OL-200.1/127 394 MAIN LOCK-MISCELLANEOUS METALS-RECESS COVERS & RAILING PLANS (SHEET NO. 1)
OL-200.1/128 395 MAIN LOCK-MISCELLANEOUS METALS-RECESS COVERS & RAILING PLANS (SHEET NO. 2)
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OL-200.1/140 403 MAIN LOCK-CULVERT BULKHEAD RECESSES-EMBEDDED METAL
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OL-200.2/1 405 INTERMEDIATE LOCK-WALL REPAIRS (SHEET 1)
OL-200.2/2 406 INTERMEDIATE LOCK-WALL REPAIRS (SHEET 2)
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OL-200.2/6 410 INTERMEDIATE LOCK-WALL REPAIRS (SHEET 6)
OL-200.2/7 411 INTERMEDIATE LOCK-WALL REPAIRS (SHEET 7)
OL-200.2/8 412 INTERMEDIATE LOCK-WALL REPAIRS (SHEET 8)
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OL-200.2/12 415 WALL REPAIR-EDGE PROTECTION (SHEET 1)
OL-200.2/13 416 WALL REPAIR-EDGE PROTECTION (SHEET 2)
OL-200.2/14 417 INTERMEDIATE & AUXILIARY LOCKS-CULVERT & CROSSOVER REPAIRS
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OL-220.1/7 454 MAIN LOCK-HYDRAULIC SYSTEM-PIPING DETAILS MONO. NOS. M32, R55 & MISC. DETAILS
OL-220.1/8 455 MAIN LOCK-HYDRAULIC SYSTEM-OPERATING LEVERS & COVER PLATES
OL-220.1/9 456 MAIN LOCK- UTILITY PIPING SYSTEM-AIR & FUEL PIPING
OL-220.1/10 457 MAIN LOCK- UTILITY PIPING SYSTEM-WATER PIPING & MISCELLANEOUS DETAILS
OL-220.2/1 458 INTERMEDIATE & AUXILIARY LOCKS-HYDRAULIC SYSTEM - SCHEMATIC PIPING DIAGRAM
OL-220.2/2 459 INTERMEDIATE & AUXILIARY LOCKS-HYDRAULIC SYSTEM - CONTROL VALVE LINKAGE - SCHEMATIC DIAGRAMS
OL-220.2/3 460 INTERMEDIATE & AUXILIARY LOCKS-HYDRAULIC PIPING-ARRANGEMENT
OL-220.2/4 461 INTERMEDIATE LOCK-HYDRAULIC, WATER & AIR PIPING
OL-220.2/5 462 INTERMEDIATE LOCK-HYDRAULIC PIPING-SECTIONS
OL-220.2/6 463 INTERMEDIATE & AUXILIARY LOCKS-HYDRAULIC PIPING-CONNECTIONS TO EXISTING PIPING
OL-220.2/7 464 INTERMEDIATE & AUXILIARY LOCKS-HYDRAULIC PIPING AT AUXILIARY LOCK
OL-220.2/8 465 MAIN, INTERMEDIATE & AUXILIARY LOCKS-FIRE PROTECTION & AUXILIARY LOCKS AIR & WATER PIPING
OL-220.2/9 466 INTERMEDIATE & AUXILIARY LOCKS-AIR PIPING AT GUARD GATES
OL-220.2/10 467 MAIN, INTERMEDIATE & AUXILIARY LOCKS-FIRE PROTECTION DETAILS
OL-230.1/2 468 MAIN LOCK-MITER GATE-SECTION THRU LEAF AND RECESS
OL-230.1/14 468A MAIN LOCK-MITER GATE-MITER GUIDE & UPPER LATCHING DEVICE
OL-230.1/18 469 MAIN LOCK-MITER GATE-FIXED METAL TOP ANCHORAGE ASSEMBLY
OL-230.1/20 470 MAIN LOCK-MITER GATE-FIXED METAL WALL QUOIN
OL-230.1/22 470A MAIN LOCK-MITER GATE- LATCHES PLAN-SECTIONS & DETAILS
OL-230.2/1 471 INTERMEDIATE LOCK-LOWER MITER GATES-GENERAL LAYOUT OF GATE & RECESSES
OL-230.2/2 472 INTERMEDIATE LOCK-LOWER MITER GATES-GENERAL DRAWING
OL-230.2/3 473 INTERMEDIATE LOCK-LOWER MITER GATE-SUPPORTING GIRDERS
OL-230.2/4 474 INTERMEDIATE LOCK-LOWER MITER GATES-QUOIN & MITER POSTS
OL-230.2/5 475 INTERMEDIATE LOCK-LOWER MITER GATES-MITER GUIDE ASSEMBLY & WALKWAY
OL-230.2/6 476 INTERMEDIATE LOCK-LOWER MITER GATES-OPERATING STRUT
OL-230.2/7 477 INTERMEDIATE LOCK-LOWER MITER GATES-GATE LATCH & DETAILS
OL-230.2/8 478 INTERMEDIATE LOCK-LOWER MITER GATES-HEEL CASTING
OL-230.2/9 479 INTERMEDIATE LOCK-LOWER MITER GATES-FENDERS
OL-230.2/10 480 INTERMEDIATE LOCK-LOWER MITER GATES-PINTLE CASTING
OL-230.2/11 481 INTERMEDIATE LOCK-LOWER MITER GATES-MISCELLANEOUS DETAILS

OL-250.1/13	520	MAIN LOCK-ELECTRICAL SYSTEM-WIRING DIAGRAM-NORTH WALL
OL-420.1/11	521	OPERATIONS BUILDING-MECHANICAL EQUIPMENT-PLANS & SECTIONS
Ol-420.1/15	522	OPERATIONS BUILDING-MECHANICAL EQUIPMENT-PIPING DIAGRAM

VOLUME 5 REFERENCE DRAWINGS

MCA100.1	X-1D	COVER SHEET VOLUME 5

COFFERDAM

GENERAL

MCA100.2	X-0	COVER SHEET VOLUME 1
MCA100.2	X-1	INDEX SHEET 1 OF 3
MCA100.2	X-1A	INDEX SHEET 2 OF 3
MCA100.2	X-1B	INDEX SHEET 3 OF 3
MCA100.2	X-2	PICTORIAL VIEW OF PROJECT
MCA100.2	X-3	LOCATION PLAN AND VICINITY MAP
MCA100.2	X-4	LOCK GENERAL PLAN
MCA100.2	X-4A	COFFERDAM GENERAL PLAN
MCA100.2	X-5	SURVEY CONTROL
MCA100.2	X-6	NOT USED
MCA100.2	X-7	NOT USED

DEMOLITION

MCA480.1	C-1	DISPOSAL AREA AND OVERALL LOCATION PLAN
MCA480.1	C-2	U.S. GOVERNMENT PROPERTY LINE & WORK LIMITS SHEET 1 OF 4
MCA480.1	C-3	U.S. GOVERNMENT PROPERTY LINE & WORK LIMITS SHEET 2 OF 4
MCA480.1	C-4	U.S. GOVERNMENT PROPERTY LINE & WORK LIMITS SHEET 3 OF 4
MCA480.1	C-4A	U.S. GOVERNMENT PROPERTY LINE & WORK LIMITS SHEET 4 OF 4
MCA480.1	C-5	STORAGE AREA SITE PLAN SHEET 1 OF 2
MCA480.1	C-6	STORAGE AREA SITE PLAN SHEET 2 OF 2
MCA480.1	C-7	DISPOSAL AREA SITE PLAN SHEET 1 OF 3
MCA480.1	C-7A	DISPOSAL AREA SITE PLAN SHEET 2 OF 3
MCA480.1	C-7B	DISPOSAL AREA SITE PLAN SHEET 3 OF 3
MCA480.1	C-8	INITIAL DEMOLITION FOR HISTORICAL MITIGATION
MCA480.1	C-9	OVERALL DEMOLITION PLAN
MCA480.1	C-10	DEMOLITION PLAN SHEET 1 OF 4
MCA480.1	C-11	DEMOLITION PLAN SHEET 2 OF 4
MCA480.1	C-11A	DEMOLITION PLAN (PHOTOGRAPH) SHEET 3 OF 4
MCA480.1	C-12	DEMOLITION PLAN SHEET 4 OF 4
MCA480.1	M-1	OVERALL MECHANICAL DEMOLITION PLAN
MCA480.1	M-2	MECHANICAL DEMOLITION SHEET 1 OF 2
MCA480.1	M-3	MECHANICAL DEMOLITION SHEET 2 OF 2
MCA480.1	M-3A	OVERALL LOCK MECHANICAL DEMOLITION PLAN
MCA480.1	M-3B	LOCK DEMOLITION PHOTOGRAPHS SHEET 1 OF 4

MCA480.1	M-3C	LOCK DEMOLITION PHOTOGRAPHS SHEET 2 OF 4
MCA480.1	M-3D	LOCK DEMOLITION PHOTOGRAPHS SHEET 3 OF 4
MCA480.1	M-3E	LOCK DEMOLITION PHOTOGRAPHS SHEET 4 OF 4

SITE INFORMATION

MCA130.1	C-13	OVERALL COFFERDAM SITE PLAN
MCA130.1	C-14	COFFERDAM SITE PLAN SHEET 1 OF 2
MCA130.1	C-15	COFFERDAM SITE PLAN SHEET 2 OF 2
MCA130.1	C-16	TOP OF ROCK MAP
MCA130.1	C-17	COFFERDAM PREDREDGING PLAN SHEET 1 OF 2
MCA130.1	C-18	COFFERDAM PREDREDGING PLAN SHEET 2 OF 2
MCA130.1	C-19	OVERALL COFFERDAM GRADING AND DRAINAGE PLAN
MCA130.1	C-20	COFFERDAM GRADING AND DRAINAGE PLAN SHEET 1 OF 3
MCA130.1	C-21	COFFERDAM GRADING AND DRAINAGE PLAN SHEET 2 OF 3
MCA130.1	C-22	COFFERDAM GRADING AND DRAINAGE PLAN SHEET 3 OF 3
MCA130.1	C-22A	COFFERDAM EMERGENCY EXITS
MCA130.1	C-23	NOT USED
MCA130.1	C-24	DISPOSAL AREA GRADING PLAN
MCA130.1	C-25	OVERALL EROSION CONTROL PLAN
MCA130.1	C-26	EROSION CONTROL PLAN SHEET 1 OF 4
MCA130.1	C-27	EROSION CONTROL PLAN SHEET 2 OF 4
MCA130.1	C-28	EROSION CONTROL PLAN SHEET 3 OF 4
MCA130.1	C-29	EROSION CONTROL PLAN SHEET 4 OF 4
MCA130.1	C-30	EROSION CONTROL DETAILS
MCA130.1	C-31	NOT USED
MCA130.1	C-32	NOT USED
MCA130.1	C-32A	NOT USED
MCA130.1	C-32B	NOT USED
MCA130.1	C-33	FENCE DETAILS
MCA130.1	C-34	OVERALL PLAN CENTERLINE STATIONING
MCA130.1	C-35	CENTERLINE STATIONING (SHEET 1 OF 3)
MCA130.1	C-36	CENTERLINE STATIONING (SHEET 2 OF 3)
MCA130.1	C-37	CENTERLINE STATIONING (SHEET 3 OF 3)
MCA130.1	C-38	CROSS SECTION STATION 15+00
MCA130.1	C-39	CROSS SECTION STATION 17+00
MCA130.1	C-40	CROSS SECTION STATION 18+25
MCA130.1	C-41	CROSS SECTION STATION 20+00
MCA130.1	C-42	CROSS SECTION STATION 21+50
MCA130.1	C-43	CROSS SECTION STATION 23+00
MCA130.1	C-44	CROSS SECTION STATION 25+00
MCA130.1	C-45	CROSS SECTION STATION 26+70
MCA130.1	C-46	CROSS SECTION STATION 30+00
MCA130.1	C-47	CROSS SECTION STATION 31+50
MCA130.1	C-48	CROSS SECTION STATION 32+70
MCA130.1	C-49	CROSS SECTION STATION 33+50

HISTORICAL MITIGATION

MCA140.1	C-50	SITE PLAN
MCA140.1	C-51	GRADING AND DRAINAGE PLAN SHEET 1 OF 2
MCA140.1	C-51A	GRADING AND DRAINAGE PLAN SHEET 2 OF 2
MCA140.1	C-52	TYPICAL SECTIONS AND DETAILS
MCA140.1	C-53	STORM DRAIN PROFILES AND PIPE SECTIONS

MCA140.1	C-54	CULVERT PLAN
MCA140.1	C-55	CULVERT JUNCTION
MCA140.1	C-56	CULVERT DETAILS
MCA140.1	A-1	ENLARGED PLANS / ELEVATIONS
MCA140.1	A-2	ARCHITECTURAL SITE PLAN & DETAILS
MCA140.1	A-3	ELEVATIONS
MCA140.1	A-4	SECTIONS
MCA140.1	A-5	PLAN, SECTIONS & ELEVATION
MCA140.1	A-6	DETAILS
MCA140.1	A-7	MISCELLANEOUS DETAILS
MCA140.1	S-1	GENERAL STRUCTURAL NOTES & DETAILS
MCA140.1	S-1A	GENERAL STRUCTURAL DETAILS
MCA140.1	E-1	ELECTRICAL DEMOLITION PLAN
MCA140.1	E-2	ELECTRICAL PLAN
MCA140.1	E-3	ELECTRICAL DETAILS
MCA140.1	E-4	ELECTRICAL DETAILS

MECHANICAL

MCA150.2	M-4	OVERALL MECHANICAL SITE PLAN
MCA150.2	M-5	MECHANICAL SITE PLAN SHEET 1 OF 4
MCA150.2	M-6	MECHANICAL SITE PLAN SHEET 2 OF 4
MCA150.2	M-7	MECHANICAL SITE PLAN SHEET 3 OF 4
MCA150.2	M-8	MECHANICAL SITE PLAN SHEET 4 OF 4
MCA150.2	M-8A	MECHANICAL SITE PLAN SHEET 4A OF 4
MCA150.2	M-9	WATERLINE PROFILE "A"
MCA150.2	M-10	WATERLINE PROFILE "B"
MCA150.2	M-10A	WATERLINE PROFILES "C & D"
MCA150.2	M-11	UTILITY DETAILS
MCA150.2	M-12	SEISMIC UTILITY DETAILS

ELECTRICAL

MCA150.2	E-5	ELECTRICAL SITE PLAN (SHEET 1 OF 2)
MCA150.2	E-6	ELECTRICAL SITE PLAN (SHEET 2 OF 2)

STRUCTURAL

MCA470.1	S-2	COFFERDAM LAYOUT UPSTREAM CELLS
MCA470.1	S-2A	360 FOOT LOCK UPSTREAM NOSE TIE-IN
MCA470.1	S-3	COFFERDAM LAYOUT DOWNSTREAM CELLS
MCA470.1	S-4	COFFERDAM PROFILE
MCA470.1	S-5	COFFERDAM DETAILS
MCA470.1	S-6	COFFERDAM DETAILS
MCA470.1	S-7	COFFERDAM DETAILS
MCA470.1	S-8	COFFERDAM DETAILS
MCA470.1	S-9	NOT USED
MCA470.1	S-10	FLOOD GATE PLAN, ELEVATION & DETAILS
MCA470.1	S-11	FLOOD GATE DETAILS
MCA470.1	S-12	BINWALL DETAILS SHEET 1
MCA470.1	S-13	BINWALL DETAILS SHEET 2
MCA470.1	S-14	DEWATERING PLAN SHEET 1 OF 2
MCA470.1	S-15	DEWATERING PLAN SHEET 2 OF 2
MCA470.1	S-16	DEWATERING DETAILS

MCA470.1 S-17 COFFERDAM INSTRUMENTATION SHEET 1 OF 2
MCA470.1 S-18 COFFERDAM INSTRUMENTATION SHEET 2 OF 2
MCA470.1 S-19 INSTRUMENTATION DETAILS
MCA470.1 S-20 600' SOUTH WALL ANCHORAGE PLANS AND SECTIONS STA. 33+36.41 TO 30+87.05
MCA470.1 S-21 600' SOUTH WALL ANCHORAGE PLANS AND SECTIONS STA. 30+87.05 TO 28+17.09
MCA470.1 S-22 600' SOUTH WALL ANCHORAGE PLANS AND SECTIONS STA. 28+17.09 TO 25+81.41
MCA470.1 S-23 600' SOUTH WALL ANCHORAGE PLANS AND SECTIONS STA. 25+18.41 TO 22+61.60
MCA470.1 S-24 600' SOUTH WALL ANCHORAGE PLANS AND SECTIONS STA. 22+61.60 TO 20+22.26
MCA470.1 S-25 600' SOUTH WALL ANCHORAGE PLANS AND SECTIONS STA. 20+22.26 TO 17+20.66
MCA470.1 S-26 600' SOUTH WALL ANCHORAGE PLANS AND SECTIONS STA. 17+20.66 TO 13+69.40
MCA470.1 S-27 600' LOCK-ANCHORAGE LOAD TRANSFER SYSTEM
MCA470.1 S-28 600' LOCK SOUTH WALL - ANCHOR POCKET LOCATIONS
MCA470.1 S-29 600' LOCK SOUTH WALL - ANCHOR POCKET LOCATIONS
MCA470.1 S-30 ANCHORAGE PLANS AND SECTIONS - 1200' SOUTH WALL STA. 33+90 TO 30+68
MCA470.1 S-31 ANCHORAGE PLANS AND SECTIONS - 1200' SOUTH WALL STA. 30+68 TO 26+85
MCA470.1 S-32 1200' LOCK ANCHORAGE - LOAD TRANSFER SYSTEM
MCA470.1 S-33 1200' LOCK SOUTH WALL - ANCHOR POCKET LOCATIONS
***3**
MCA470.1 S-34 **NOT USED**
MCA470.1 S-35 **NOT USED** ***3**
MCA470.1 S-36 NOT USED
MCA470.1 S-37 CRACK REPAIRS-M7 & M8-PLAN & ELEVATION
MCA470.1 S-37A CRACK REPAIRS-M13-PLAN & ELEVATION
MCA470.1 S-38 CRACK REPAIRS-M14 & M15-PLAN & ELEVATION
MCA470.1 S-39 STABILIZATION OF 360' LOCK NORTH WALL
MCA470.1 S-39A STABILIZATION OF 360' LOCK NORTH WALL
MCA470.1 S-40 SWING BRIDGE - PLAN AND ELEVATION
MCA470.1 S-41 PROTECTIVE SURFACE - SWING BRIDGE CENTER PIER
MCA470.1 S-42 STABILIZATION OF SWING BRIDGE NORTH ABUTMENT
MCA470.1 S-43 PROTECTIVE SURFACE - SWING BRIDGE SOUTH ABUTMENT
MCA470.1 S-44 BUTTRESS PLAN 1200' LOCK SOUTH WALL
MCA470.1 S-45 BUTTRESS & MONOLITH CROSS SECTIONS
MCA470.1 S-46 BUTTRESS REINFORCING
MCA470.1 S-47 MONOLITH BUTTRESS SECTIONS AND DETAILS

McALPINE SUPPORT FACILITIES

OL400.5 U1-1 UTILITY PLAN (SHEET 1 OF 2)
OL400.5 U1-2 UTILITY PLAN (SHEET 2 OF 2)
OL400.5 E1-2 ELECTRICAL SCHEDULES & DETAILS

OLMSTED LOCKS AND DAM

OLM100.1 X-6 GENERAL PLAN
OLM100.1 X-22 PLAN KENTUCKY CELLS

OLM100.1	X-22A	SALVAGE MATERIALS STORAGE PLAN AT KENTUCKY BANK LOCATION
OLM500.1	H-1	HYDROGRAPHS 1966 TO 1969
OLM500.1	H-2	HYDROGRAPHS 1969 TO 1973
OLM500.1	H-3	HYDROGRAPHS 1974 TO 1977
OLM500.1	H-4	HYDROGRAPHS 1978 TO 1981
OLM500.1	H-5	HYDROGRAPHS 1982 TO 1985
OLM500.1	H-6	HYDROGRAPHS 1986 TO 1989
OLM500.1	H-7	HYDROGRAPHS 1990 TO 1993
OLM500.1	H-8	HYDROGRAPHS 1994 TO 1997
OLM500.1	H-9	HYDROGRAPHS 1998 TO 2000

1.8 AS-BUILT DOCUMENTS

3 November 1998 (Version 1)

1.8.1 General.

This section covers the completion of as-built drawings and as-built specifications, as a requirement of the contract.

1.8.1.1 As-Built Drawings

An as-built drawing is a construction drawing revised to reflect the final as-built conditions of the project as a result of modifications, changes, corrections to the project design required during construction, submittals and extensions of design. The terms "drawings," "contract drawings," "drawing files," "working as-built drawings" and "final as-built drawings" refer to contract drawings which are revised to be used for the "RECORD DRAWING AS-BUILTS".

1.8.1.2 As-Built Specifications

As-built specifications are the construction specifications as modified by changes (contract mods, ACO approved variations from the construction specifications and drawings, to include field adjustments necessary in the performance of the work).

1.8.2 Maintenance of Working As-Built Drawings and Specifications

The Contractor shall revise 2 sets of paper prints of drawings and specifications by red-line process to show the as-built conditions during the prosecution of the project. These as-built marked prints shall be kept current on a weekly basis and available on the jobsite at all times. Changes from the contract plans which are made in the work or additional information which might be uncovered in the course of construction shall be accurately and neatly recorded as they occur by means of details and notes. Changes must be reflected on all sheets affected by the change. The working as-built marked prints will be jointly reviewed for accuracy and completeness by the Contracting Officer and the Contractor prior to submission of each monthly pay estimate. These monthly meetings shall be included in the Project

Schedule, which is prepared in accordance with Section 01320 PROJECT SCHEDULE. The working as-built drawings and specifications shall show the following information, but not be limited thereto:

a. The actual location, kinds and sizes of all sub-surface utility lines. In order that the location of these lines and appurtenances may be determined in the event the surface openings or indicators become covered over or obscured, the as-built drawings shall show, by offset dimensions to two permanently fixed surface features, the end of each run including each change in direction. Valves, splice boxes and similar appurtenances shall be located by dimensioning along the utility run from a reference point. The average depth below the surface of each run shall also be recorded.

b. The location and dimensions of any changes within the building structure.

c. Correct grade, elevations, cross section, or alignment of roads, earthwork, structures or utilities if any changes were made from contract plans.

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d. Additional as-built information that exceeds the detail shown on the Contract Drawings. These as-built conditions include those that reflect structural details, fabrication, erection, installation plans and placing details, reinforcing steel drawings, concrete lift drawings, pipe sizes, insulation material, dimensions of equipment foundations and layouts, equipment, sizes, mechanical room layouts and other extensions of design, that were not shown in the original contract documents because the exact details were not known until after the time of approved shop drawings. **Submittals identified as type SD-04 Drawings shall be revised to show as-built conditions, and will serve as the as-built record without actual incorporation into the contract drawings. All such submittals must include, along with the hard copy of the drawings, CADD files of the drawings in a commercially available digital format, compatible with the Using Agency System (see paragraph 1.8.11).**

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e. The topography, invert elevations and grades of drainage installed or affected as part of the project construction.

f. Changes or modifications which result from the final inspection.

g. Where contract drawings or specifications present options, only the option selected for construction shall be shown on the final as-built prints.

h. If borrow material for this project is from sources on Government property, or if Government property is used as a spoil area, the Contractor shall furnish a contour map of the final borrow pit/spoil area elevations.

g. If fire protection and fire detection related systems are included in this project, the as-built drawings will include detailed information for all aspects of the systems including wiring, piping, and equipment drawings.

The Contractor will be provided files at the beginning of construction for use during the construction phase which are to be maintained during construction and for the preparation of as-builts. The Contractor shall enter changes and corrections on blue line prints on a weekly basis in accordance with Paragraph "Maintenance of Working As-Built Drawings and Specifications" and update the CADD as-built drawings and electronic specification files on a weekly basis. Both paper and electronic documents shall be available at all times and shall be provided promptly to the Contracting Officer when requested, but not less than monthly. The Contractor shall be responsible for backup of electronic files during construction and for controlling release of information.

1.8.3 Retainage

The Contractor shall include in his schedule of values, the cost of as-built document preparation. This value shall include all requirements of this clause:

Maintenance of working as-built drawings
Maintenance of working as-built specifications
Conversion of submittals and other miscellaneous documents into electronic files
Creation of "Record As-Built Drawings & Specifications" (by CADD dwgs and SpecsIntact specifications as specified herein.)
Creation of a CD containing all required files.
Submittal of as-built documents in the required media forms and numbers of copies

Although no separate payment will be made for as-built document preparation (reference paragraph 1.8.12), the Contractor will be required to include this work in his schedule of values for the purpose of retainage. If the Contractor fails to maintain the working as-built drawings and specifications as specified herein, the Contracting Officer will deduct from the monthly progress payment an amount representing the estimated cost of bringing the as-built documents up to date. This monthly deduction will continue until an agreement can be reached between the Contracting Officer and the Contractor regarding the accuracy and completeness of working as-built documents.

1.8.4 Preliminary Submittal

Six (6) weeks prior to occupancy of this facility by the Government, the Contractor shall submit one (1) set of the original working as-built documents to the Contracting Officer for review and approval. These working as-built marked drawings and specifications shall be neat, legible and accurate. The review by Government personnel will be expedited to the maximum extent possible. Upon approval, the working as-built marked documents will be returned to the Contractor for use in preparation of final as-built documents. If upon review, the working as-built marked documents are found to contain errors and/or omissions, they will be returned to the Contractor for corrections. The Contractor shall complete the corrections and return the working as-built marked documents to the Contracting Officer within 10 calendar days.

1.8.5 Preparation of Final As-Built Drawings and Specifications

Upon approval of the working as-built prints submittal, the Contractor will be furnished, by the Government, one set of contract drawings in CADD and one set of electronic specification files(if not previously provided) with all amendments incorporated, to be used for final as-built drawings. Any contract modifications which were developed by revision of contract drawing CADD files or electronic specification files, will already have the modifications reflected in the files provided to the Contractor. The contract documents will be furnished in the formats specified in paragraphs 1.8.7 and 1.8.11. The drawings shall be modified as may be necessary to correctly show the features of the project as it has been constructed by bringing the contract set into agreement with approved working as-built prints, adding such additional drawings as may be necessary. These documents are part of the permanent records of this project and the Contractor shall be responsible for the protection and safety thereof until returned to the Contracting Officer. Any documents damaged or lost by the Contractor shall be satisfactorily replaced by the Contractor at no expense to the Government.

In the event the Contractor accomplishes additional work which changes the as-built conditions of the facility, after submission and approval of the working as-built documents, he shall be responsible for the addition of these changes to the working as-built documents and also to the final as-built documents.

1.8.6 Markings and Indicators

Changes shall be annotated with a triangle and sequential number at the following locations:

a. bottom of the revised detail
b. right hand and bottom border aligned with the revised detail
c. the revision block of the title block.

Separate markings shall be made for each modification negotiated into the contract.

1.8.7 Preparation of Final As-Built Specifications

Final as-built specifications shall be prepared in Specsintact and the electronic files shall be placed on the same CD ROM that contains the "As-Built" CADD files, if applicable. The front sheet of the specifications shall contain an identification which clearly labels the specifications as representing as-built conditions and shall be dated with the date of the submittal.

1.8.8 Preparation of Other As-Built Documents

All other non-electronic documents which may include design analysis, catalog cuts, certification documents that are not available in native electronic format shall be scanned and provided in an organized manner in Adobe .pdf format.

1.8.9 Submittal of Final As-Built Documents

At the time of Beneficial Occupancy of the project, Final As-Built documents shall be provided to the Contracting Officer in the formats described in paragraphs 1.8.7 and 1.8.11 .

1.8.10 Partial Occupancy

For projects where portions of construction are to be occupied or activated prior to overall project completion, including portions of utility systems, as-built drawings for those portions of the facility being occupied or activated shall be supplied at the time the facility is occupied or activated. This same as-built information previously furnished must also be shown on the final set of as-built drawings at project completion.

1.8.11 Computer Aided Design and Drafting (CADD) Drawings
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Only personnel proficient in the preparation of CADD drawings shall be employed to modify the contract drawings or prepare additional new drawings. The Contractor CADD technician(s) responsible for the preparation of the As-built drawings shall be located at the project site. The Contractor CADD technician(s) shall have a minimum of one year experience not including school or 18 months schooling on Microstation CADD software system. The qualifications of the Contractor CADD technician(s) shall be submitted to the Contracting Officer for approval. Additions and corrections to the contract drawings shall be equal in quality to that of the originals. Line work, line weights, lettering, layering conventions, and symbols shall be the same as the original line work, line weights, lettering, layering conventions, and symbols. If additional drawings are required, they shall be prepared using the specified electronic file format applying the same guidance specified for original drawings. Three dimensional (3D) elements shall be placed in files in their proper locations when utilizing 3D files with spatially correct elements. The title block and drawing border to be used for any new final as-built drawings shall be identical to that used on the contract drawings. Additions and corrections to the contract drawings shall be accomplished using CADD media files supplied by the Government. All work by the C ontractor shall be done on files in the format in which they are provided. Translation of files to a different format, for the purpose of As-Built production, and then retranslating back to the format originally provided, will not be acceptable. These contract drawings will already be compatible with the Using Agency's system when received by the Contractor. The Using Agency uses Microstation **Version 7** CADD software system. The media files shall be supplied by the Contractor to the COR on ISO 9660 Format CD-ROM. The Contractor shall be responsible for providing all program files and hardware necessary to prepare final as-built drawings. The Contracting Officer will review final as-built drawings for accuracy and the Contractor shall make all required corrections, changes, additions, and deletions.
***1**

a. When final revisions have been completed, the cover sheet drawing shall show the wording "RECORD DRAWING AS-BUILT" followed by the name of the Contractor in letters at least 3/16 inch high. All other contract drawings shall be marked either "AS-BUILT" drawing denoting no revisions on the sheet or "REVISED AS-BUILT" denoting one or more revisions. Original contract drawings shall be dated in the revision block.

b. Revision markers defined in paragraph 1.8.6 shall be placed as follows:

(1) at the detail, placed in the design file where the revised graphics are located and the revision was placed
(2) right hand and bottom border in the drawing sheet file revision block of the title block in the drawing sheet file.

c. After receipt by the Contractor of the approved working as-built prints and the original contract drawings files the Contractor shall, within 30 calendar days, make the final as-built submittal. This submittal shall consist of 2 sets of completed final as-built drawings on separate media consisting of both CADD files (compatible with the Using Agency's system on electronic storage media identical to that supplied by the Government) and mylars; 2 blue line prints of these drawings and the return of the approved marked working as-built prints. They shall be complete in all details and identical in form and function to the contract drawing files supplied by the Government. Any transactions or adjustments necessary to accomplish this is the responsibility of the Contractor. The Government reserves the right to reject any drawing files it deems incompatible with its CADD system. All paper prints, drawing files and storage media submitted will become the property of the Government upon final approval. Failure to submit final as-built drawing files and marked prints as specified shall be cause for withholding any payment due the Contractor under this contract. Approval and acceptance of final as-built drawings shall be accomplished before final payment is made to the Contractor.

1.8.12 Payment

No separate payment will be made for as-built drawings required under this contract, and all costs in conjunction therewith, shall be considered a subsidiary obligation of the Contractor.

1.9 NOT USED (AS-BUILT DOCUMENTS FOR DESIGN BUILD PROJECTS)

1.10 EQUIPMENT DATA
15 June 1990

Real Property Equipment. Contractor shall be required to make an Equipment-in-Place list of all installed equipment furnished under this contract. This list shall include all information usually listed on manufacturer's name plate. The form is part of SPECIAL CONTRACT REQUIREMENTS and is included following the SPECIAL CONTRACT REQUIREMENTS, so to positively identify the piece of property. The list shall also include the cost of each piece of installed property F.O.B. construction site. For each of the items which is specified herein to be guaranteed for a specified period from the date of acceptance thereof, the following information shall be given: The name, serial and model number address of equipment supplier, or manufacturer originating the guaranteed item. The Contractor's guarantee to the Government of these items will not be limited by the terms of any manufacturer's guarantee to the Contractor. The list shall be furnished as one (1) reproducible and three (3) copies and shall be furnished to the Contracting Officer not later than thirty (30) calendar days prior to completion of any segment of the contract work which has an incremental completion date.

Maintenance and Parts Data. The Contractor will be required to furnish a brochure, catalog cut, parts list, manufacturer's data sheet or other publication which will show detailed parts data on all other equipment subject to repair and maintenance procedures not otherwise required in Operations and Maintenance Manuals specified elsewhere in this contract. Distribution of directives shall follow the same requirements as listed in paragraph above.

1.11 PHYSICAL DATA (APR 1984) FAR 52.236-4.
2 January 1996

Data and information furnished or referred to below are furnished for the Contractor's information. The Government will not be responsible for any interpretation or conclusion drawn from the data or information by the Contractor.

a. Physical Conditions indicated on the drawings and in the specifications are the result of site investigations by surveys, borings, test pits and probings. Cores and soil samples from results of site investigations are available for inspection at various locations in the Louisville area, subject to prior arrangement at the Office of the District Engineer, Engineering Division, Steve Durrett, 600 Dr. Martin Luther King, Jr. Place, Louisville, Kentucky 40201, (502) 315-6370.

b. Weather Conditions. The Contractor shall make his own investigations as to weather conditions at the site. Data may be obtained from various National Weather Service offices located generally at airports of principal cities, the nearest to this project being:

Louisville, KY WSFO
NWS Forecast Office, NOAA
6201 Therlery Ln.
Louisville, KY 40229
502-968-6025

Historical data for all areas may be obtained from:

U. S. Department of Commerce
National Climatic Center
Federal Building
Asheville, N. C. 28801

***3 *1**
c. Transportation Facilities. Roads and railroads in the general area are shown on the drawings. Access ways shall be investigated by the Contractor to satisfy himself as to their existence and allowable use. **It is anticipated that there will be a ramp into the cofferdam area located at each cofferdam arm, descending along the existing land wall to the interior floor elevation. These ramps will be built under prior contract and may be used by the Contractor as directed by the Contracting Officer. It is**

anticipated that the ramps will be built of concrete rubble and soil fill with a 15-foot (usable width) gravel surface at a grade of approximately 12%. The ramps shall be removed by the Contractor at any time during the Contract in order to complete his work. The Contractor shall not use the road or the parking area of the Resident Engineer's Office. The Contractor will be held responsible for any and all damages attributable to the actions of the Contractor, his subcontractors, and his suppliers outside the limits of construction shown on the drawings or designated by the Contracting Officer. This shall include damage to existing roads, drainage structures, electric or telephone facilities, pavement and other structures and facilities. All such damage shall be repaired to the satisfaction of the proper municipal or state authorities by the Contractor and at his expense.

***1 *3**

d. All hauling over roads to and from the project will be subject to the approval of the proper municipal or state authorities, and the Contractor shall make the necessary arrangements, at his expense, with such authorities for the use of such roads and shall comply with their requirements in connection with such use.

e. All access roads and haul roads, whether built under this contract or not, shall be made available at no cost to Government forces, LG&E personnel, and other Government contractors working in the vicinity. The project roads at the McAlpine site shall not be closed. In particular, availability of access to Shippingport Island, the LG&E Hydropower Plant, the Government Offices, the private business located at 27th and Marine Streets, and the riverwalk shall be maintained at all times. Vehicle speed shall be as posted or slower if directed. The Government shall suspend or restrict usage of project roads at any time the requirements specified are not met or if it is in the best interests of the Government.

f. The steel bascule bridge that crosses the existing McAlpine 1200-foot lock has a vertical clearance of 15 feet and a horizontal clearance of 16 feet. The bridge is raised an average of 20 times per day to allow for operation of the 1200-foot lock, and remains inaccessible to vehicular and pedestrian traffic an average of 10 to 15 minutes each time it is raised.

g. The steel swing bridge that crosses the McAlpine 600-foot lock has a vertical clearance of approximately 21 feet and a horizontal clearance of 15 feet, 4 inches. The swing bridge will not be swung for construction purposes except on a very limited basis as necessary for the execution of work as determined and approved by the Contracting Officer. A request shall be made to the Resident Engineer at least 48 hours prior to the need to swing the bridge and shall be scheduled such that intermittent access to the island (not less than hourly) can be accommodated. Operation of the swing bridge will not be possible once construction activities have progressed to the point of impeding its rotation.

h. The bascule bridge crossing the existing 1200-foot lock and the swing bridge crossing the 600-foot lock are subject to the following weight restrictions: For 3-axle vehicles configured similar to AASHTO HS-20, the bridges are restricted to a gross vehicle weight of 36 tons. For 2-axle vehicles configured similar to AASHTO H-20, they are restricted to a gross vehicle weight of 25 tons. The maximum axle load for any vehicle on the bridges is 20 tons.

i. The new access bridge crossing the new and existing 1200-foot locks will be subject to the following weight restrictions when it is complete: For 3-axle vehicles configured similar to AASHTO HS-20, the bridge is restricted to a gross vehicle weight of 36 tons. For 2-axle vehicles configured similar to AASHTO H-20, it is restricted to a gross vehicle weight of 25 tons.

j. Once every two years the bascule bridge crossing the existing 1200-foot lock and the swing bridge crossing the 600-foot lock will be inspected. The first inspection of the bascule bridge will occur in the summer of 2004. The first inspection of the swing bridge will occur in the summer of 2003. Each inspection of the bascule bridge will last approximately 2 days. Each inspection of the swing bridge will last approximately 21 days. During these inspections, the bridges will be closed for approximately one hour during each shift.

k. During flooding periods, closures are installed in the levee at 26th street and 27th street. The closure in the levee at 26th street is installed when the Ohio River upper pool reaches elevation 456.0 (48 feet on the upper gauge). The closure in the levee at 27th street is installed when the Ohio River upper pool reaches elevation 436.7 (16.7 feet on the upper gauge).

l. The Contractor will not be permitted to place any equipment or materials on the south wall of the 1200-foot lock wall, except for those equipment and materials necessary to detension the anchors in this wall. The Contractor may not have access to the 1200-foot lock wall without the approval of the Contracting Officer. The Contractor will not be permitted to stockpile materials on the cofferdam cells, the south wall of the 600-foot lock, the flat area behind the south wall of the 600-foot lock, or within 50 feet of the crest of the slope on the south bank. No construction loading will be permitted on the wall or the flat area behind the wall, other than normal vehicular traffic that can travel on a highway without a permit, unless approved by the Contracting Officer.

m. The Contractor shall take the necessary precautions to preserve the cutoff wall on the surge basin dike, as shown on Contract Drawing C-13.

n. Any item of Government property encountered by the Contractor that must be temporarily removed in order to carry out construction must be temporarily replaced, with the replacement providing the same function, until the original item is restored. Any such replacement shall be subject to approval of the Contracting Officer.

o.
Hydrographs are shown on Contract Drawings H-1 through H-9, and elevation duration curves are attached at the end of this section.

***2**
p. When the existing 1200-foot lock is filled, the upper pool experiences a surge in elevation and velocity. For more information, reference the attachments at the end of this section. ***2**

1.12 UTILITIES (APR 1984) FAR 52.236-14 (Para. 1.12.1 & 1.12.2 only).
15 June 1990

a. Availability and Use of Utility Services. The Contractor is responsible for his own electrical power service requirements for the lock construction including power for the cofferdam ground water control system. Currently adequate power exists to dewater and unwater the cofferdam. Power characteristics are 13.8 kV, three phase. Power at the site can be obtained from Louisville Gas and Electric Company (LG&E), 820 West Broadway, P.O. Box 32020, Louisville, Kentucky 40232. The POC is Jim Holderman, (502) 627-3384). The Contractor is responsible for his own water requirements for the Cofferdam Construction. The Contractor will be allowed to connect on to the Corps of Engineers waterline. However, the Contractor will need to install a meter and will be responsible for payment for the amount of water used. The Contractor will be responsible for reading the meter monthly, and shall pay the Corps of Engineers for the water used on a quarterly basis. Exact specifics on whom payment shall be made to shall be coordinated with the Contracting Officer. Separately metered water service is available at the current cofferdam contractor's area west of the Resident Engineer's Office.

b. The Contractor, at its expense and in a workmanlike manner satisfactory to the Contracting Officer, shall install and maintain all necessary temporary connections and distribution lines, and all meters required to measure the amount of each utility used for the purpose of determining charges. Before final acceptance of the work by the Government, the Contractor shall remove all the temporary connections, distribution lines, meters, and associated paraphernalia.

Alteration of Utilities:

a. Where changes and relocations of utility lines are noted to be performed by others, except as noted below in parts b. and c., the Contractor shall give the Contracting Officer at least thirty (30) days written notice in advance of the time that the change or relocation is required.

b. Where changes and relocations of LG&E utility lines associated with the new bridge are noted to be performed by others, the Contractor shall give the Contracting Officer written notice in advance of the time that the change or relocation is required which allows LG&E thirty (30) days to schedule the work and sixty (60) days to complete.

c. Where changes to the railroad crossing are noted to be performed by others, the Contracting Officer shall coordinate with the Contractor as to a mutually agreeable schedule for the crossing work. The railroad shall be allowed to close the road for a maximum of 48 hours to complete the work.

d. In the event that utility lines and crossing work have not been changed or relocated in the time frames outlined above and delay is occasioned to the completion of the work under contract, the Contractor will be entitled to a time extension equal to the period of time lost by the Contractor after the expiration of established period. Any modification to existing or relocated lines required as a result of the Contractor's method of operation shall be made wholly at the Contractor's expense and no additional time will be allowed for delays incurred by such modifications.

Interruptions of Utilities:

a. No utility services shall be interrupted by the Contractor to make connections, to relocate, or for any purpose without approval of the Contracting Officer.

b. Request for Permission to shut down services shall be submitted in writing to the Contracting Officer not less than 72 hours prior to date of proposed interruption. The request shall give the following information:

(1) Nature of Utility (Gas, L.P. or H.P., Water, etc.)

(2) Size of line and location of shutoff.

(3) Buildings and services affected.

(4) Hours and date of shutoff.

(5) Estimated length of time services will be interrupted.

c. Services shall not be shutoff until receipt of approval of the proposed hours and date from the Contracting Officer.

d. Shutoffs which will cause interruption of Government work operations as determined by the Contracting Officer shall be accomplished during regular non-work hours or on non-work days of the Using Agency without any additional cost to the Government. The 1200-foot lock and maintenance building are operated 24 hours a day, 7 days a week. Any interruption of utilities to these facilities must be accomplished in one four-hour period, as approved by the Contracting Officer. The Contractor shall be responsible for providing temporary utilities for any time that utility interruption is necessary outside of this one four-hour period.

e. Where shutoff of water lines interrupts service to fire hydrants or fire sprinkler systems, the Contractor shall arrange his operations and have sufficient material and personnel available to complete the work without undue delay or to restore service without delay in event of emergency.

f. Flow in gas mains which have been shut off shall not be restored until the Government inspector has determined that all items serviced by the gas line have been shut off.

1.13 QUANTITY SURVEYS (APR 1984) FAR 52.236-16
24 February 1992

a. Quantity surveys shall be conducted, and the data derived from these surveys shall be used in computing the quantities of work performed and the actual construction completed and in place.

b. The Contractor shall conduct the original and final surveys and surveys for any periods for which progress payments are requested. All these surveys shall be conducted under the direction of a representative of the Contracting Officer, unless the Contracting Officer waives this requirement in a specific instance. The Government shall make such computations as are necessary to determine the quantities of work performed or finally in place. The Contractor shall make the computations based on the surveys for any periods for which progress payments are requested.

c. Promptly upon completing a survey, the Contractor shall furnish the originals of all field notes and all other records relating to the survey or to the layout of the work to the Contracting Officer, who shall use them as necessary to determine the amount of progress payments. The Contractor shall retain copies of all such material furnished to the Contracting Officer.

d. All Contractor surveys shall be conducted by a Land Surveyor licensed in the State of Kentucky.The Land Surveyor must have the capacity to keep up with a contract of this size.

1.14 LAYOUT OF WORK (APR 1984) FAR 52.236-17
15 June 1990 **(Version 1)**

The Contractor shall lay out its work from Government-established coordinates and bench marks indicated on the drawings, and shall be responsible for all measurements in connection with the layout. The Contractor shall furnish, at his own expense, all stakes, templates, platforms, equipment, tools, materials, and labor required to lay out any part of the work. The Contractor shall be responsible for executing the work to the lines and grades that may be established or indicated by the Contracting Officer. The Contractor shall also be responsible for maintaining and preserving all stakes and other marks established by the Contracting Officer until authorized to remove them. If such marks are destroyed by the Contractor or through its negligence before their removal is authorized, the Contracting Officer may replace them and deduct the expense of the replacement from any amounts due or to become due to the Contractor.

1.15 NOT USED (LINES, GRADES AND LIMITS)

1.16 PERFORMANCE OF WORK BY THE CONTRACTOR (APR 1984) FAR 52.236-1
(Para. 15 only) 15 June 1990

The Contractor shall perform on the site, and with its own organization, work equivalent to at least 20 percent of the total amount of work to be performed under the contract. This percentage may be reduced by a supplemental agreement to this contract if, during performing the work, the Contractor requests a reduction and the Contracting Officer determines that the reduction would be to the advantage of the Government.

a. For purposes of this paragraph "WORK BY THE CONTRACTOR" is defined as prime Contractor direct contract labor (including testing and layout personnel), exclusive of other general condition or field overhead personnel, material, equipment, or subcontractors. The "TOTAL AMOUNT OF WORK" is defined as total direct contract labor (including testing and layout personnel), exclusive of other general condition or field overhead personnel, material, or equipment.

b. Within 7 days after the award of any subcontract, either by himself or a subcontractor, the Contractor shall deliver to the Contracting Officer a completed SF 1413, "Statement and Acknowledgment". The form shall include the subcontractor's acknowledgement of the inclusion in his subcontract of the clauses of this contract entitled "Davis-Bacon Act," "Contract Work Hours and Safety Standards Act-Overtime Compensation," "Apprentices and Trainees," "Compliance with Copeland Regulations," "Withholding of Funds," "Subcontracts," "Contract Termination-Debarment," and "Payrolls and Basic Records." Nothing contained in this contract shall create any contractual relation between the subcontractor and the Government.

1.17 SUPERINTENDENCE OF SUBCONTRACTORS
24 February 1992

a. The Contractor shall be required to furnish the following, in addition to the superintendence required by CONTRACT CLAUSE: SUPERINTENDENCE BY THE CONTRACTOR.

(1) If more than 50 percent and less than 70 percent of the value of the contract work is subcontracted, one superintendent shall be provided at the site and on the Contractor's payroll to be responsible for coordinating, directing, inspecting and expediting the subcontract work.

(2) If 70 percent or more of the value of the work is subcontracted, the Contractor shall be required to furnish two such superintendents to be responsible for coordinating, directing , inspecting and expediting the subcontract work.

b. If the Contracting Officer, at any time after 50 percent of the subcontracted work has been completed, finds that satisfactory progress is being made, he may waive all or part of the above requirements for additional superintendence subject to the right of the Contracting Officer to reinstate such requirement if at any time during the progress of the remaining work he finds that satisfactory progress is not being made.

1.18 IDENTIFICATION OF EMPLOYEES.
15 June 1990

a. The Contractor shall be responsible for furnishing an identification badge/card to each employee prior to the employees work on-site, and for requiring each employee engaged on the work to display identification as may be approved and directed by the Contracting Officer. Contractor and subcontractor personnel shall wear identifying markings on hard hats clearly identifying the company for whom the employee works. All prescribed identification shall immediately be delivered to the Contracting Officer for cancellation upon release of the employee. When required by the Contracting Officer, the Contractor shall obtain and submit fingerprints of all persons employed or to be employed on the project.

1.19 NOT USED (CONTRACTOR-PREPARED NETWORK ANALYSIS SYSTEM)

1.20 WARRANTY OF CONSTRUCTION (MAR 1984) ALTERNATE 1 (APR 1984) FAR 52.246-21I.
15 January 1998

1.20.1 General Requirements

1.20.1.1 In addition to any other warranties in this contract, the Contractor warrants, except as provided in paragraph 1.20.1.10 of this clause, that work performed under this contract conforms to the contract requirements and is free of any defect in equipment, material, or design furnished, or workmanship performed by the Contractor or any subcontractor or supplier at any tier.

1.20.1.2 This warranty shall continue for a period of 1 year from the date of final acceptance of the work. If the Government takes possession of any part of the work before final acceptance, this warranty shall continue for a period of 1 year from the date the Government takes possession.

(a) As a part of the one year warranty inspection, the Contracting Officer will conduct an infrared roof survey on any project involving a membrane roofing system. This survey will be conducted in accordance with ASTM C1153-90, "Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging". In accordance with paragraph 1.20.1.3 and 1.20.1.4 below, the Contractor shall be required to replace all damaged materials and to locate and repair sources of moisture penetration.

1.20.1.3 The Contractor shall remedy at the Contractor's expense any failure to conform, or any defect. In addition, the Contractor shall remedy at the Contractor's expense any damage to Government-owned or controlled real or personal property, when that damage is the result of--

(a) The Contractor's failure to conform to contract requirements; or

(b) Any defect of equipment, material, workmanship, or design furnished.

1.20.1.4 The Contractor shall restore any work damaged in fulfilling the terms and conditions of this clause. The Contractor's warranty with respect to work repaired or replaced will run for 1 year from the date of repair or replacement.

1.20.1.5 The Contracting Officer will the Contractor, in writing, (see para. 1.20.2.3 and 1.20.5) within a reasonable time after the discovery of any failure, defect, or damage.

1.20.1.6 If the Contractor fails to remedy any failure, defect, or damage within a reasonable time after receipt of notice, (see para. 1.20.5) the Government shall have the right to replace, repair, or otherwise remedy the failure, defect, or damage at the Contractor's expense.

1.20.1.7 With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for work performed and materials furnished under this contract, the Contractor shall--

(a) Obtain all warranties that would be given in normal commercial practice;

(b) Require all warranties to be executed, in writing, for the benefit of the Government, if directed by the Contracting Officer; and

(c) Provide names, addresses, and telephone numbers of all subcontractors, equipment suppliers, or manufacturers with specific designation of their area of responsibilities if they are to be contacted directly on warranty corrections; and

(d) Enforce all warranties for the benefit of the Government, if directed by the Contracting Officer.

1.20.1.8 In the event the Contractor's warranty under paragraph of this clause has expired, the Government may bring suit at its expense to enforce a subcontractor's, manufacturer's, or supplier's warranty.

1.20.1.9 Unless a defect is caused by the negligence of the Contractor or subcontractor or supplier at any tier, the Contractor shall not be liable for the repair of any defects of material or design furnished by the Government nor for the repair of any damage that results from any defect in Government-furnished material or design.

1.20.1.10 This warranty shall not limit the Government's rights under the Inspection and Acceptance clause of this contract with respect to latent defects, gross mistakes, or fraud.

1.20.1.11 Defects in design or manufacture of equipment specified by the Government on a "brand name and model" basis, shall not be included in this warranty. In this event, the Contractor shall require any subcontractors, manufacturers, or suppliers thereof to execute their warranties, in writing, directly to the Government.

1.20.2 Performance Bond

1.20.2.1 The Contractor's Performance Bond will remain effective throughout the construction warranty period and warranty extensions.

1.20.2.2 In the event the Contractor or his designated representative(s) fails to commence and diligently pursue any work required under this clause, and in a manner pursuant to the requirements thereof, the Contracting Officer shall have a right to demand that said work be performed under the Performance Bond by making written notice on the surety. If the surety fails or refuses to perform the obligation it assumed under the Performance Bond, the Contracting Officer shall have the work performed by others, and after completion of the work, may make demand for reimbursement of any or all expenses incurred by the Government while performing the work, including, but not limited to administrative expenses.

1.20.2.3 Following oral or written notification of required warranty repair work, the Contractor will respond as dictated by para. 1.20.5. Written verification will follow oral instructions. Failure of the

Contractor to respond will be cause for the Contracting Officer to proceed against the Contractor as outlined in the paragraph 1.20.2.2 above.

***3**

1.20.2.4 In addition to the Performance Bond requirements of "Warranty of Construction", the Performance Bond(s) will remain in effect for any occurrence of Latent Defect for a period of six years beyond the warranty period.

1.20.2.5 For the purposes of the "Contract Disputes Act", the Surety shall be considered the same as a contractor to the Government."

***3**

1.20.3 Pre-Warranty Conference

Prior to contract completion and at a time designated by the Contracting Officer, the Contractor shall meet with the Contracting Officer to develop a mutual understanding with respect to the requirements of this clause. Communication procedures for Contractor notification of warranty defects, priorities with respect to the type of defect, reasonable time required for Contractor response, and other details deemed necessary by the Contracting Officer for the execution of the construction warranty shall be established/reviewed at this meeting. In connection with these requirements and at the time of the Contractor's quality control completion inspection, the Contractor will furnish the name, telephone number and address of a licensed and bonded company which is authorized to initiate and pursue warranty work action on behalf of the Contractor. This point of contact will be located within the local service area of the warrantied construction, will be continuously available, and will be responsive to Government inquiry on warranty work action and status. This requirement does not relieve the Contractor of any of his responsibilities in connection with other portions of this provision.

1.20.4 Equipment Warranty Identification Tags

1.20.4.1 The Contractor shall provide warranty identification tags on all Contractor and Government furnished equipment which he has installed.

(a) The tags shall be similar in format and size to the exhibits provided by this specification, they shall be suitable for interior and exterior locations, resistant to solvents, abrasion, and to fading caused by sunlight, precipitation, etc. These tags shall have a permanent pressure-sensitive adhesive back, and they shall be installed in a position that is easily (or most easily) noticeable. Contractor furnished equipment that has differing warranties on its components will have each component tagged.

(b) Sample tags shall be submitted for Government review and approval. These tags shall be filled out representative of how the Contractor will complete all other tags.

(c) Tags for Warrantied Equipment: The tag for this equipment shall be similar to the following. Exact format and size will be as approved.

EQUIPMENT WARRANTY

CONTRACTOR FURNISHED EQUIPMENT

MFG MODEL NO.

SERIAL NO.

CONTRACT NO.

CONTRACTOR NAME

CONTRACTOR WARRANTY EXPIRES

MFG WARRANTY(IES) EXPIRE

EQUIPMENT WARRANTY
GOVERNMENT FURNISHED EQUIPMENT

MFG MODEL NO.

SERIAL NO.

CONTRACT NO.

DATE EQUIP PLACED IN SERVICE

MFG WARRANTY(IES) EXPIRE

(d) If the manufacturer's name (MFG), model number and serial number are on the manufacturer's equipment data plate and this data plate is easily found and fully legible, this information need not be duplicated on the equipment warranty tag. The Contractor warranty expires (warranty expiration date) and the final manufacturer's warranty expiration date will be determined as specified by para. 1.20.1.

1.20.4.2 Execution. The Contractor will complete the required information on each tag and install these tags on the equipment by the time of and as a condition of final acceptance of the equipment.

1.20.4.3 Payment. The work outlined above is a subsidiary portion of the contract work, and has a value to the Government approximating 5% of the value of the Contractor furnished equipment. The Contractor will assign a value of that amount in the breakdown for progress payments mentioned in the Contract Clause: PAYMENTS UNDER FIXED-PRICE CONSTRUCTION CONTRACTS.

1.20.4.4 Equipment Warranty Tag Replacement. As stated in para. 1.20.1.4, the Contractor's warranty with respect to work repaired or replaced shall run for one year from the date of repair or replacement. Such activity shall include an updated warranty identification tag on the repaired or replaced equipment. The tag shall be furnished and installed by the Contractor, and shall be identical to the original tag, except that the

Contractor's warranty expiration date will be one year from the date of acceptance of the repair or replacement.

1.20.5 Contractor's Response to Warranty Service Requirements. Following oral or written notification by the Contracting Officer or an authorized representative of the installation designated in writing by the Contracting Officer, the Contractor shall respond to warranty service requirements in accordance with the "Warranty Service Priority List" and the three categories of priorities listed below.

First Priority Code 1 Perform on site inspection to evaluate situation, determine course of action, initiate work within 24 hours and work continuously to completion or relief.

Second Priority Code 2 Perform on site inspection to evaluate situation, determine course of action, initiate work within 48 hours and work continuously to completion or relief.

Third Priority Code 3 All other work to be initiated within 5 work days and work continuously to completion or relief.

The "Warranty Service Priority List" is as follows:

Code 2 Air Conditioning Systems

Code 1 Watertight Doors

Code 1 Electrical
a. Power failure
b. Traffic control devices
c. Security lights
d. Navigation control lights
e. PC hardware/software
f. PLC system
g. UPS system
h. Manual control system
i. Emergency power system (generator, automatic transfer switch, etc.)
j. CCTV system
k. Fire alarm system

Code 1 Heating Systems

Code 1 Mechanical
a. Fuel storage tank
b. Equipment room ventilation fans
c. Hydraulic system

Code 2 Mechanical
a. Air compressors

Code 1 Plumbing

a. Sumps pumps

Code 2 Plumbing

a. Sewage pump
b. Fixture drain, supply line commode, or water pipe leaking
c. Commode leaking at base

Code 1 Roof Leaks

Temporary repairs will be made where major damage to property is occurring.

Code 2 Roof Leaks

Where major damage to property is not occurring, check for location of leak during rain and complete repairs on a Code 2 basis.

Code 3 Water (Exterior)

a. Raw water pumps

Code 2 Water, Hot

1.20.5.2 Should parts be required to complete the work and the parts are not immediately available the Contractor shall have a maximum of 12 hours after arrival at the job site to provide the Contracting Officer or an authorized representative of the installation designated in writing by the Contracting Officer, with firm written proposals for emergency alternatives and temporary repairs for Government participation with the Contractor to provide emergency relief until the required parts are available on site for the Contractor to perform permanent warranty repair. The Contractors proposals shall include a firm date and time that the required parts shall be available on site to complete the permanent warranty repair. The Contracting Officer or an authorized representative of the installation designated in writing by the Contracting Officer, will evaluate the proposed alternatives and negotiate the alternative considered to be in the best interest of the Government to reduce the impact of the emergency condition. Alternatives considered by the Contracting Officer or an authorized representative of the installation designated in writing by the Contracting Officer will include the alternative for the Contractor to "Do Nothing" while waiting until the required parts are available to perform permanent warranty repair. Negotiating a proposal which will require Government participation and the expenditure of Government funds shall constitute a separate procurement action by the using service.

1.21 PAYMENT FOR MOBILIZATION AND PREPARATORY WORK (JAN 1997) DFARS 252.236-7003
20 August 1997 **(Version 1)**

a. The Government will make payment to the Contractor under the procedures in this clause for mobilization and preparatory work under item "Mobilization, Demobilization & Preparatory Work" as listed in the Bidding Schedule.

b. Payments will be made for actual payments by the Contractor on work preparatory to commencing actual work on the construction items for which payment is provided under the terms of this contract, as follows--

(1) For construction plant and equipment exceeding $25,000 in value per unit (as appraised by the Contracting Officer at the work site) acquired for the execution of the work;

(2) Transportation of all plant and equipment to the site;

(3) Material purchased for the prosecution of the contract, but not to be incorporated in the work;

(4) Construction of access roads or railroads, camps, trailer courts, mess halls, dormitories or living quarters, field headquarters facilities, and construction yards;

(5) Personal services; and
(6) Hire of plant.

c. Requests for payment must include--

(1) An account of the Contractor's actual expenditures;

(2) Supporting documentation, including receipted bills or copies of payrolls and freight bills; and

(3) The Contractor's documentation--

(I) Showing that it has acquired the construction plant, equipment, and material free from all encumbrances;

(ii) Agreeing that the construction plant, equipment, and material will not be removed from the site without the written permission of the Contracting Officer; and

(iii) Agreeing that structures and facilities prepared or erected for the prosecution of the contract work will be maintained and not dismantled prior to the completion and acceptance of the entire work, without the written permission of the Contracting Officer.

d. Upon receiving a request for payment, the Government will make payment, less any prescribed retained percentage, if--

(1) The Contracting Officer finds the--

(I) Construction plant, material, equipment, and the mobilization and preparatory work performed are suitable and necessary to the efficient prosecution of the contract; and

(ii) Preparatory work has been done with proper economy and efficiency.

(2) Payments for construction plant, equipment, material, and structures and facilities prepared or erected for prosecution of the

contract work do not exceed--

(I) The Contractor's cost for the work performed less the estimated value upon completion of the contract; and

(ii) 100 percent of the cost to the Contractor of any items having no appreciable salvage value; and

(iii) 75 percent of the cost to the Contractor of items which do have an appreciable salvage value.

e.(1) Payments will continue to be made for bid item "Mobilization, Demobilization & Preparatory Work", and all payments will be deducted from the contract price for this item, until the total deductions reduce this item to zero, after which no further payments will be made under this item.

(2) If the total of payments so made does not reduce this item to zero, the balance will be paid to the Contractor in the final payment under the contract.

(3) The retained percentage will be paid in accordance with the Payments to Contractor clause of this contract.

f. The Contracting Officer shall determine the value and suitability of the construction plant, equipment, materials, structures and facilities. The Contracting officer's determinations are not subject to appeal.

g. Plant & Material Removal After Contract Termination: Should the contract be terminated as provided in paragraph 1.61 because of the failure of Congress to provide additional funds for its completion, the Contractor may be permitted to remove plant and material on which payments for preparatory work have been made subject to an equitable deduction from the amounts due to the Contractor to reimburse the United States for the unabsorbed value of such plant and material.

1.22 NOT USED (PAYMENT FOR MOBILIZATION AND DEMOBILIZATION (DEC 1991) DFARS 252.236-7004.)

1.23 SALVAGE MATERIALS AND EQUIPMENT.
24 February 1992

a. The Contractor shall maintain adequate property control records for all materials or equipment specified to be salvaged below or elsewhere in the specifications. These records shall be in accordance with the Contractor's system of property control. The Contractor shall submit his plan for the System of Property Control for approval by the Contracting Officer. The Contractor shall be responsible for the adequate storage and protection of all salvaged materials and equipment and shall replace, at no cost to the Government, all salvage materials and equipment which are broken or damaged during salvage operations as the result of his negligence, or while in his care.

b. The following is a list of items that are to be salvaged by the Contractor for future reuse by the Government.

1. Cofferdam Sheet Piles:
Sheet piling including PZ piling will be declared as salvage once the sheet has been pulled from the water and part or all of it is inspected by the Government and is found to be reusable. The reusable sheet pile will be stored at the project site at a location determined by the Contracting Officer. See specification section 02221 for sheet piling storage requirements. Payment for storage of reusable sheet piling will be made under the bid item "Storage of Reusable Cofferdam Sheet Piling." There is an option for all of the sheet pile to become property of the Contractor. Payment for this option will be made under the bid item "Reusable Cofferdam Sheet Piling" as listed in the Bidding Schedule. No payment will be made under "Storage of Reusable Cofferdam Sheet Piling" if this option is invoked.

2. Generators:
The generators shall be transported and stored at the project site at a location to be determined by the Contracting Officer. Payment for transportation, handling, and storage of the generators will be made under the bid item "Removal and Storage of Salvageable Generators." There is an option for the generators to become property of the Contractor. Payment for this option will be made under the bid item "Salvageable Generators" as listed in the Bidding Schedule. No payment will be made under "Removal and Storage of Salvageable Generators" if this option is invoked.

3. Sandstone Blocks:
The top of the existing north abutment of the swing bridge and the existing 360-foot lock nose pier shall be demolished as shown on Contract Drawing C-2A. These structures contain sandstone block masonry. The intact, whole sandstone blocks shall be transported and stored at the project site, on Shippingport Island north of the existing concrete ramp to the surge basin. Stone shall be placed near the road to be accessible by a tractor trailer. No broken sandstone blocks or rubble shall be salvaged or stored at this location. No payment shall be made for special handling of sandstone blocks removed from the abutment or nose pier.

c. The area designated for storage of the generators shall be prepared with geotextile fabric and six inches of compacted CA 6 stone material. The designated storage area may be one or more areas. Each area will require the fabric and stone storage pad. The Contractor is responsible for removing trees as need in the designated storage area. The area designated for storage of the sheet pile shall be prepared as directed in specification section 02221.

1.24 IDENTIFICATION OF GOVERNMENT-FURNISHED PROPERTY (APR 1984) FAR 52.245-3.
2 January 1991

a. The Government will furnish to the Contractor the property identified in the Schedule to be incorporated or installed into the work or used in performing the contract. The listed property will be furnished at the place it is currently being used or as specified below. When the property is transferred or delivered, the Contractor shall verify its quantity and condition and acknowledge receipt in writing to the Contracting Officer. The Contractor shall also report in writing to the

Contracting Officer within 24 hours of transfer any damage to or shortage of the property as received. All such property shall be installed or incorporated into the work at the expense of the Contractor, unless otherwise indicated in this contract.

Location of GFP:

***3 *2**
The cofferdam and associated equipment is located where it is currently being used at the McAlpine site. A portion of the sheet piling is stored at the McAlpine Lock project site, on Shippingport Island north of the existing concrete ramp to the surge basin. Additional sheet piling is located on the Kentucky bank at the Olmsted Locks construction site in Olmsted, Illinois. For the location of the Olmsted sheet piling, see the Olmsted Locks Reference drawings OLM100.1, sheets X-6, X-22, and X-22A. Only sheet pile located in bays 3 and 5, as shown on sheet X-22A, is government furnished property. All other sheet pile at the Olmsted Kentucky Bank Storage Area shall not be disturbed by the contractor. **Access to the Olmsted Kentucky Bank Storage Area is by river only. No land access is available.** See Olmsted Locks Reference drawings OLM500.1, sheets H-1 through H-9 for the hydrographs of the Olmsted site. The elevation duration curves for the Olmsted site are attached at the end of section 00800. The wall armor is stored in a storage site off New Dam Road at the Olmsted Locks construction site in Olmsted, Illinois. The storage area is a flat open field easily accessible by trucks. A photograph of the wall armor storage site is attached at the end of section 00800. The sandstone blocks are located at the McAlpine Lock project site, on Shippingport Island north of the existing concrete ramp to the surge basin. Desks for the Control Room of Service Building A shall be f.o.b. truck at the project site. **The timber-head units are located at the Louisville Repair Station on Shippingport Island.** ***2 *3**

b. The Contractor is required to furnish all means necessary to load the property for transport. The Contractor is also required to transport the property to the jobsite at its own expense.

c. Each item of property to be furnished under this clause shall be identified in the Schedule by quantity, item, and description.

Quantity	Item and Description
1	Cofferdam (including all cells, connecting arcs, berms, floodway, soldier pile wall, temporary anchors, lighting, emergency stairways, and emergency alarm system)
1	Floodway bridge
2	Flood gates
1	Unwatering platforms and piping
1	Dewatering system (including Transformer Stations, Pad Mounted Generators, Standby Generator, Submersible Pumps, Electrical switches & panelboards, Primary and Secondary conductors, Discharge piping, and Concrete Bollards)
150	PS 27.5 Sheet piles (109 LF or longer), located at the McAlpine Lock project site

***2**
35 **PS 27.5 Sheet piles of varying length and condition, located at the McAlpine Lock project site (This sheet piling is for the Contractor's use and shall become property of the Contractor)**
See attachment PS 27.5 Sheet piles, located at the Olmsted Locks construction site (For quantity and lengths of this sheet piling, see attachment at the end of this section)
24,864 LF Wall Armor AT 08x58.4 Sections (56 LF or longer) ***2**
***1**
30 **Large, rough sandstone blocks for contractor's use in producing the required stone benches and stone bollards as indicated on the plans**
2 **Control Consoles** for Control Room of Service Building A
4 **Auxiliary Work Tables for Control Room of Service Building A**
***1**
***2**
2 **Timber-head units to be used as bollards for the security gate entrance at the south bridge approach** ***2**
***3** **1** **Hydraulic pump to be used for tensioning miter gate diagonals. The pump shall remain the property of the Government after the gate prestressing is finished. The pump is located at the Louisville Repair Station on Shippingport Island.** ***3**

d. The Contractor shall be responsible for maintaining, servicing, and repairing the cofferdam, floodway bridge, flood gates, unwatering system and dewatering system, including maintenance of the embankment areas, cofferdam stability berms, and stone protection adjacent thereto during the life of this contract. For additional details see specification section 02170 COFFERDAM.

e. The sheet piles located at the McAlpine Lock project site shall be furnished for construction of Alternative 1, Approach Wall Drilled Shaft Design or Alternate 2, Approach Wall Cell Design. The sheet piles located at the Olmsted Locks construction site shall be furnished for construction of Alternate 2, Approach Wall Cell Design only.

f. The government-furnished wall armor AT 08x58.4 sections are shown on Contract Drawing S-384. These sections are unpainted. Each section shall be split by the Contractor to provide two wall armor "T" sections as shown in Section 1/S384. The Contractor shall be responsible for splitting the sections and all fabrication, sandblasting and surface preparation, and painting necessary to produce the final wall armor. Anchor straps and stiffener plates shall be provided by the Contractor.

1.25 NOT USED (AGGREGATE SOURCES)

1.26 PROJECT SIGN
1 August 1996

General. The Contractor shall furnish and erect at the location directed one project sign.

Exact placement location will be designated by the Contracting Officer. The panel sizes and graphic formats have been standardized for visual consistency throughout all Corps operations.

Panels are fabricated using HDO plywood with dimensional lumber uprights and bracing.

All legends are to be painted in the sizes and styles as specified by the graphic formats shown at the end of this section. The signs (including back and edges), posts and braces shall be given two coats of Benjamin Moore No. 120-60 poly-silicone enamel or approved equal before lettering. The 4' x 4' right section of the project sign shall be white with black lettering. The upper 2' x 2' left section of the project sign shall be communication red (CR) with white lettering. The lower 2' x 2' left section of the project sign shall beblue with white lettering . Paint colors shall be as follows:

Black - Federal Standard 595a Color Number 27038
White - Federal Standard 595a Color Number 27875
Red - PANTONE 032
Blue - Sherwin Williams Signature Blue No. SW1798

An example of the sign including mounting and fabrication details are also provided at the end of this section.

Name of the project shall be as follows:

McAlpine Lock Replacement Project
Lock Construction

Name of the designer shall be as follows:

Louisville District

Name of local sponsor shall be as follows:

Inland Waterways Trust Fund

Erection and Maintenance.

a. The signs shall be erected at the designated location(s). Signs shall be plumb and backfill of post holes shall be well tamped to properly support the signs in position throughout the life of the contract. The signs shall be maintained in good condition until completion of the contract, shall remain the property of the Contractor, and shall be removed from the site upon completion of work under the contract.

b. The Corps of Engineers logo and the local sponsor's logo will be provided by the Contracting Officer.

c. Payment. No separate payment will be made for furnishing and erecting the project signs as specified and costs thereof shall be considered a

subsidiary obligation of the Contractor.
***1**

***1**

1.27 NOT USED (CONTRACTOR QUALITY CONTROL)

1.28 WAGE RATES
1 February 1995

The decision of the Secretary of Labor, covering rates of wages, including fringe benefits to be paid laborers and mechanics performing work under this contract, is attached hereto. The payment for all classes of laborers and mechanics actually employed to perform work under the contract will be specified in the following contract clauses: DAVIS-BACON ACT, CONTRACT WORK HOURS AND SAFETY STANDARDS ACT, and THE COPELAND ACT.

1.29 PURCHASE ORDERS
15 June 1990

Five copies of all purchase orders, for items requiring shop inspection, showing firm names and addresses, shall be submitted to the Contracting Officer when orders for materials are placed. Orders shall be so worded or marked that each item, piece or member can be definitely identified on the drawings. Purchase prices are not necessary and may be obliterated from the copies of the purchase orders furnished.

1.30 INTERFERENCE WITH TRAFFIC AND PUBLIC AND PRIVATE PROPERTY.
15 June 1990
***1**

a. The Contractor at all times shall dispose his plant and conduct the work in such manner as to cause as little interference as possible with private and public travel. The Contractor shall submit a Traffic Control Plan (TCP) outlining the traffic control scheme and phasing which will maintain public traffic through the project. The TCP shall maintain the following constraints and/or sequence of work:

- The existing By-Pass Road to be removed as shown on Sheet C-12A of the contract drawings, shall remain open to the maximum extent possible during construction of the bridge.
- The asphalt surface course of Marine Street shall not be placed until the end of the contract. The initial pavement section shall include the stone subbase and base courses and at least 2.5" of asphalt base. The Contractor shall maintain the asphalt base throughout the contract. **Prior to completion of the project, the Contractor shall repair the asphalt base by milling and/or leveling as necessary to achieve smoothness tolerances required by specification section 02741. Immediately before placing the surface course, the underlying course shall be cleaned of dust and debris and a tack coat applied in accordance with the contract specifications.**
- Construction traffic shall be separated from public traffic to the maximum extent possible. Temporary roads may be constructed to provide for the safe movement of traffic. Obtain the Contracting Officer's approval for all temporary facilities constructed solely to accommodate construction operations. When approved, construct and maintain such temporary facilities, including furnishing and applying surfacing and dust control material. Pave all temporary roadways intended for public traffic for

maintenance of traffic.

- When a section of roadway must be closed to through traffic, provide and maintain satisfactory temporary facilities for the maintenance of local traffic.

- Furnish, erect, and maintain all traffic control devices, including flaggers, necessary to maintain through and local traffic according to the MUTCD. Traffic control devices include channelization devices, signs, temporary pavement markings, and other items necessary to maintain and control traffic in the construction zone.

b. The Contractor shall provide maintenance of public roads and bridges, existing and new, within the project site during the life of the contract. Maintenance shall include, but not be limited to, removal of debris in catch basins, curb inlets, and bridge scuppers, snow/ice removal, and daily street cleaning.

c. Damage to roads **and bridges** shall be repaired to as good a condition as they were prior to the beginning of work and to the satisfaction of the Contracting Officer. Damage is defined as gouging or rutting of the pavement in excess of 2 inches. The Contractor shall survey the condition of the roads monthly with the Contracting Officer, and shall repair any damage noted in these inspections as directed by the Contracting Officer. All potholes shall be repaired immediately. The Contractor shall also be responsible for repairing any damage to 26th Street (truck bypass) **from the entrance to Lannan City Park.**

d. The Contractor shall provide and maintain as may be required by the State of Kentucky Transportation Cabinet, proper barricades, fences, danger signals and lights, provide a sufficient number of watchmen, and take such other precautions as may be necessary to protect life, property and structures, and shall be liable for and hold the Government free and harmless from all damages occasioned in any way by his act or neglect, or that of his agents, employees, or workmen.

e. In order to keep proper control of vehicles in the work area, all Contractor's vehicles and supplier's vehicles shall display suitable permanent identification as approved by the Contracting Officer.

f. Project employees shall be allowed access to all areas in performance of their duties 24 hours a day.

***1**

1.31 SEQUENCE OF WORK.

The following sequence of work requirements shall be met:

a. The Contractor shall coordinate with Norfolk-Southern railroad 30 days in advance of work in the vicinity of the railroad tracks. (Reference Contract Drawing C-47.)

b. Follow the construction sequence requirements for the approach wall shown on Contract Drawings S-237I, S-238, S-239N, S-241, S-246, S-246A, S-247, and S-247B.

c. Demolition of the existing soldier pile wall at the north abutment of the swing bridge shall not begin until the new access bridge is complete and the bridge is in service. (Reference Contract Drawing C-2A.)

d. Demolition of the swing and bascule bridges and their supports shall not begin until the construction of monoliths L20 and SM22 and the new access bridge is complete and the bridge is in service. (Reference Contract Drawings C-12 and S-322 to S-374D.)

e. Construction of the bridge piers on monoliths L20 and SM22 of the new lock shall not begin until the construction of monoliths L20 and SM22 is complete. (Reference Contract Drawings S-106 to S-110, S-143 to S-147, and S-338 to S-340.)

***2**

f. The drilled shafts, to be used for the floating mooring bitt sockets, shall be drilled at the locations shown in the plans. These shall be drilled to elevation **367** before excavating the lock chamber to its founding elevations. After excavation of the lock chamber foundation, the mooring bitt sockets shall be cleaned of any loose debris, before forming the concrete around the socket. (Reference Contract Drawing S-211.)

***2**

g. Bridge piers no. 4 and 5 shall be constructed such that access to the Resident Engineer's office and the existing private business is always maintained. Work in this area shall be performed during night and weekend hours in order to minimize traffic disruptions. (Reference Contract Drawings S-322 and S-323.)

h. Portions of the approach walls cannot be built until portions of the cofferdam have been removed. (Reference Contract Drawings C-1 and C-2.)

i. Construction sequence requirements listed in paragraph 1.30.a. regarding the removal of the existing By-Pass Road and the paving of Marine Street shall be followed.

j. Construction sequence requirements listed in Section 02170 COFFERDAM, paragraph 3.5, regarding temporary cofferdam berm removal for excavation of the upstream intake at monolith SM 23 and the downstream diffuser, shall be followed.

***1**

k. The new esplanade fill adjacent to Monoliths M31 and M32 shall not be constructed above pre-existing grades until the concrete rock anchor piers, the vertical strand anchors, and the inclined anchor bars are completed on the esplanade face of these monoliths. **The excavation for construction of the rock anchor piers on M31 and M32 shall not be commenced until the new access bridge is complete and the bridge is in service, and, the upstream pool elevation is not expected to exceed elevation 425 during the construction of the rock anchor piers. Demolition of the Swing Bridge abutment and roadway fill will be required for the excavation.** The horizontal anchor bars shall be installed, tensioned, and accepted prior to tensioning the vertical strand anchors. In addition, the temporary excavation shall be restored to pre-existing grades prior to tensioning the vertical strand anchors. **(Reference Contract Drawings S-177A to S-177C.)**

***1**

l. Removal of the berm for construction of the new retaining wall shall be done when the upper pool is below elevation 425. (Reference Contract Drawing S-1.)

m. Excavation to rock will be necessary for construction of the cast-in-place concrete cut-off wall. This excavation shall not be performed when the upstream pool elevation is at or above elevation 425, or can reasonably be expected to be above this elevation prior to the fill materials being replaced. Once the excavation is initiated, construction of the cut-off wall shall proceed expeditiously until the embankment can be replaced to the original grades. (Reference Contract Drawing S-1.)

n. Before the cofferdam is rewatered, the inclined toe anchors in Monoliths M4 and M13 of the existing 1200-foot lock shall be detensioned. These anchors shall not be detensioned when the upper pool level is anticipated to exceed elevation 425 prior to rewatering. The vertical anchors in Monoliths M1 through M15 shall be detensioned following rewatering. (Reference Contract Drawing C-1.)
o. The cofferdam cannot be rewatered until all of the all of the requirements listed in Section 02170 COFFERDAM, paragraph 3.7 are complete.
p. The existing metal towers located upstream of the existing bridges currently support a Louisville Gas & Electric Co. (LG&E) owned communications line. This line must remain in place until completion of the bridge. After bridge completion, it will be routed by LG&E through a conduit attached to the bridge. After this work is complete, the towers and their foundations shall be demolished by the Contractor. (Reference Contract Drawing E-12.)
q. The new lock and the existing 1200-foot lock shall not be filled simultaneously. In addition, filling of the new lock shall not be initiated during the five-minute window starting 28 minutes after the existing lock has begun filling and ending 33 minutes after the existing lock has begun filling.
r. See also paragraph COMMENCEMENT, PROSECUTION AND COMPLETION OF WORK for requirements regarding the commencement of administrative work and physical work.
***1**
s. Construction sequence requirements listed in Section 02210 SUBSURFACE DRILLING, SAMPLING, AND TESTING, paragraph 1.7.1, regarding core drilling at monolith foundations, shall be followed.
***1**

1.32 GOVERNMENT FIELD OFFICE FACILITIES AND SERVICES.
1 August 1996

a. Lock Field Office Located in Cofferdam. The Contractor shall furnish a field office located down in the cofferdam for the exclusive use of the Government quality assurance representatives. The field office shall be a 12'x30' trailer with an office at one end. Each door shall have steps and a landing on the outside. It shall be watertight, lockable, with open/close windows, properly heated, with electrical hookup, adequately lighted, with wall receptables, ventilated, air conditioned, and furnished with one lockable desk (30" x 60"), one swivel chair, two 4-drawer filing cabinets, one 36" x 72" table, one plan table with stool, eight straight back chairs, one rack for holding full-size drawings, one small refrigerator, one microwave oven, mini-blinds on the windows, and one port-o-let for use by the Government. All furnishings shall be new. Electrical service and service to the port-o-let will be the responsibility of the Contractor. The Contractor shall provide cleaning and maintenance services to include weekly cleanup, sweeping, mopping, dusting, and trash removal. The Contractor shall also furnish handsoap, toilet paper, hand towels, trash cans, and liners. The Contractor will also be responsible for setting up, leveling, and anchoring the trailer. The Contractor may be required to move the trailer five times during the life of the Contract at the Contracting Officer's request. Each time the trailer is moved, electrical hook-up will be required for heating, cooling, power, and lighting. The field office and furnishings will revert back to the Contractor once the cofferdam is rewatered.
***2**

b. The Contractor shall be responsible for mowing grass in all areas of the worksite throughout the life of the contract, including the fenced-in areas at the visitor's area and the area around the Resident Engineer's office. The grass shall be mowed any time it is above 1-1/2 inches long. The fenced-in areas at the visitor's area and the area around the Resident Engineer office shall receive broad-leaf control twice a year, once in April and once in June.

c. Payment. No separate payment will be made for these ***2**
Contractor-furnished services, and all costs thereof shall be incidental to the various bid items of the contract.

1.33 NOT USED (COMPLIANCE WITH POST/BASE REGULATIONS)

1.34 EQUIPMENT AND OWNERSHIP AND OPERATING EXPENSE SCHEDULE (MAR 1995)
EFAR 52.231-5000.
20 March 1997

a. This does not apply to terminations. See 52.249,5000, Basis for Settlement of Proposals and FAR Part 49.

b. Allowable cost for construction and marine plant and equipment in sound workable condition owned or controlled and furnished by a contractor or subcontractor at any tier shall be based on actual cost data for each piece of equipment or groups of similar serial and series for which the Government can determine both ownership and operating costs from the contractor's accounting records. When both ownership and operating costs cannot be determined for any piece of equipment or groups of similar serial or series equipment from the contractor's accounting records, costs for that equipment shall be based upon the applicable provisions of EP 1110-1-8, Construction Equipment Ownership and Operating Expense Schedule, Region II. Working conditions shall be considered to be average for determining equipment rates using the schedule unless specified otherwise by the Contracting Officer. For equipment not included in the schedule, rates for comparable pieces of equipment may be used or a rate may be developed using the formula provided in the schedule. For forward pricing, the schedule in effect at the time of negotiations shall apply. For retroactive pricing, the schedule in effect at the time of negotiations shall apply.

c. Equipment rental costs are allowable, subject to the provisions of FAR 31.105(d)(ii) and FAR 31.205-36. Rates for equipment rented from an organization under common control, lease-purchase arrangements, and sale-leaseback arrangements, will be determined using the schedule, except that actual rates will be used for equipment leased from an organization under common control that has an established practice of leasing the same or similar equipment to unaffiliated lessees.

d. When actual equipment costs are proposed and the total amount of the pricing action exceeds the small purchase threshold, the Contracting Officer shall request the Contractor to submit either certified cost or pricing data, or partial/limited data, as appropriate. The data shall be submitted on Standard Form 1411, Contract Pricing Cover Sheet.

e. Whenever a modification or equitable adjustment of contract price is required, the contractor's cost proposals for equipment ownership and operating expenses shall be determined in accordance with the requirements of SPECIAL CONTRACT REQUIREMENT: EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE. A copy of EP 1110-1-8, "Construction Equipment Ownership and Operating Expense Schedule" is available for review at the office of the District Engineer, Room 821, 600 Dr. Martin Luther King, Jr. Place, Louisville, Kentucky, or a copy may be ordered from the Government Printing Office at a cost of $11.00 by calling telephone no. (301) 953-7974.

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10	008-022-00263-4
11	008-022-00264-2
12	008-022-00265-1

1.35 LABOR, EQUIPMENT, AND MATERIAL REPORTS
15 June 1990

Daily Equipment Report. The Contractor shall submit a daily report of all Contractor-owned or rented equipment at the jobsite. A similar report is required for all subcontractor equipment. The subcontractor's report may be separate or included with the Contractor's report provided the equipment is adequately identified as to ownership. The required equipment report shall include each item of equipment (hand-operated small tools or equipment excluded) on the job and shall specifically identify each item as to whether it is Contractor-owned or rented, shifts, hours of usage, down time for repairs, and standby time. Identification of the equipment shall include make, model and plant number of all items. Separate identification by a key sheet providing these data may be utilized with the daily report indicating the type of equipment and the equipment plant numbers. The format of the Daily Equipment Report will be as approved by the Government in the field.

Labor, Equipment & Material Reports for Extra Work/Cost. A Report shall also be submitted by the Contractor listing any labor, equipment and materials expended on and/or impacted by any change order directed by the Government and for which total price/time agreement has not been reached. These requirements also apply to subcontractors at any tier. The same

Report is required at any time the Contractor claims or intends to claim for extra costs whether or not there is Government recognition (constructive changes). This requirement is in addition to any Contractor "Notice" or "Reservation of Rights". Submittal of such a report will not be construed as satisfying the "Notice" required under the "Changes" clause or any other clause. But, absence of such Reports submitted to the Government contemporaneously with the alleged extra work/cost will be considered as evidence that no such extra work/cost occurred that are chargeable to the Government.

The Report shall be detailed to the degree required by the Government in the field and shall contain the following as a minimum:

a. The cause of the extra labor, equipment or materials costs.

b. For extra labor - Indicate crew, craft, hours, location and cost. Describe nature or type of extra costs, i.e, extra work, overtime, acceleration, interference, reassignment, mobilizations and demobilizations, supervision, overhead, type of inefficiency, etc.

c. For extra equipment - Indicate type and description, hours, location, cost; whether working, idle, standby, under repair, extra work involved, etc.

d. For extra materials - Indicate type and description, where used, whether consumed, installed or multi-use, quantity, cost, extra work involved, etc.

e. Affected activities - Relate to Contract Schedule (Network Analysis); demonstrate whether delay or suspension is involved.

f. Segregate all entries by prime and each subcontractor.

g. Summarize costs daily and by cumulative subtotal or with frequency required by the Government.

This Report will not be considered as evidence that any of the alleged extra costs actually occurred. The Report will be used to check against over obligation of funds for change orders directed prior to price/time agreement and to track alleged extra costs the Contractor considers otherwise chargeable against the Government. The Government may respond at any interval to either challenge, amend or confirm the Report. Absence of a Government response is not to be considered acquiescence or denial. The Government may order work stoppage if deemed necessary to avoid overobligation of funds. The frequency of the report shall be daily or as otherwise approved by the Government representative in writing.

1.36 NOT USED (ILLINOIS RETAILER'S OCCUPATIONAL TAX AND USE TAX)

1.37 NOT USED (INDIANA SALES AND USE TAX)

1.38 NOT USED (OHIO SALES AND USE TAX)

1.39 PROGRESS PHOTOGRAPHS

18 Nov 1999)

The Contractor shall, during the progress of the work, furnish the Contracting Officer photographs, slides, digital photographs (furnished on CD-ROM) and negatives depicting construction progress. The photographic work furnished shall be commercial quality as determined by the Contracting Officer. The photography shall be performed between the first and fifth of each month and the photographs, slides, digital photographs and negatives delivered to the Contracting Officer not later than the 15th of each month taken. A minimum of ten views from different positions shall be taken as directed to show, inasmuch as possible, work accomplished during the previous month. At least, one set of photographs, slides, digital photographs and negatives will be made at completion of the contract, after final inspection by the Contracting Officer. Aerial photographs shall be furnished in lieu of conventional photographs periodically, at least on alternate months, at the discretion of the Contracting Officer. The photographs shall be 8"x10" color prints and the slides 35 mm color. The digital photographs shall be Kodak KDC format or equivalent. Each photograph and slide shall be identified on the face of the picture or the border of the slide giving date made, contract title and number, location of work, as well as a brief description of work depicted. Each negative and digital photograph file will be identified with the same information on a sheet of paper by cross-referencing to the number on the negative and the digital photograph filename. Two copies of photographs and slides, along with the original negatives and digital photograph files of each view taken, shall be furnished to the Contracting Officer by the time stipulated above. In addition, no separate payment will be made for these services and all costs in connection thereto shall be considered a subsidiary obligation of the Contractor.

1.40 PAYMENT FOR MATERIALS DELIVERED OFFSITE. (MAR 1995) EFARS 52.232-5000. 20 March 1997

Pursuant to CONTRACT CLAUSE: PAYMENTS UNDER FIXED-PRICE CONSTRUCTION CONTRACTS, materials delivered to the Contractor at locations other than the site of the work may be taken into consideration in making payments if included in payment estimates and if all the conditions of the CONTRACT CLAUSES are fulfilled. Payment for items delivered to locations other than the worksite will be limited to:

(1) Materials required by the technical provisions,

(2) Materials that have been fabricated to the point where they are identifiable to an item of work required under this contract.

Such payment will be made only after receipt of paid or receipted invoices or invoices with canceled check showing title to the items in the prime contract and including the value of material and labor incorporated into the item.

1.41 INSURANCE--WORK ON A GOVERNMENT INSTALLATION (SEP 1989) FAR 52.228-5. 17 July 1992

The Contractor shall, at its own expense, provide and maintain during the entire performance of this contract at least the kinds and minimum amounts of insurance required in the Schedule or elsewhere in the contract.

(1) Coverage complying with State laws governing insurance requirements, such as those requirements pertaining to Workman's Compensation and Occupational Disease Insurance. Employer's Liability Insurance shall be furnished in limits of not less than $100,000.00 except in states with exclusive or monopolistic funds.

(2) Comprehensive General Liability Insurance for bodily injury coverage shall be furnished in limits of not less than $500,000 per occurrence.

(3) Comprehensive Automobile Liability Insurance for both bodily injury and property damage, shall be furnished in limits of not less than $200,000.00 per person, $500,000.00 per accident for bodily injury, and $20,000.00 per accident for property damage. When the Financial Responsibility or Compulsory Insurance Law of the State requires higher limits, the policy shall provide for coverage of at least those higher limits.

(4) Marine Liability Insurance furnished in a limit of not less than $1,000,000.00 per accident for property damage.

(5) Pollution Insurance (Oil Spills, etc.) furnished in a limit of not less than $1,000,000.00 per accident.

The Contractor shall, at its own expense, provide and maintain during the performance of work at or near the railroad at least the kinds and minimum amounts of insurance listed below.

(1) Commercial General Liability Insurance having a combined single limit of not less than $2,000,000 per occurrence for all loss, damage, cost, and expenses. Said policy shall include "explosion, collapse, and underground hazard" ("XCU") coverage, shall be endorsed to name Norfolk Southern Railway Company as an additional insured, and shall include a severability of interests provision.

(2) Railroad Protective Liability Insurance having a combined single limit of not less than $2,000,000 each occurrence and $6,000,000 in the aggregate applying separately to each annual period. Said policy shall provide coverage for all loss, damage or expense arising from bodily injury and property damage liability, and physical damage to property attributed to acts or omissions at the job site. The named insured shall read: Norfolk Southern Railway Company, Three Commercial Place, Norfolk, Virginia 23510-2191, Attn: D.W. Fries, Director Risk Management.

Before commencing work under this contract, the Contractor shall submit to the Contracting Officer in writing that the required insurance certification has been obtained. The policies evidencing required insurance shall contain an endorsement to the effect that any cancellation or any material change adversely affecting the Government's interest shall not be effective (1) for such period as the laws of the State in which this contract is to be performed prescribe, or (2) until 30 days after the insurer or the Contractor gives written notice to the Contracting Officer, whichever period is longer.

The Contractor shall insert the substance of this clause, including this paragraph, in subcontracts under this contract that require work on a Government installation and shall require subcontractors to provide and maintain the insurance required in the Schedule or elsewhere in the contract. The Contractor shall maintain a copy of all subcontractors' proofs of required insurance, and shall make copies available to the Contracting Officer upon request.

***1**

1.42 **IMPLEMENTATION OF GOVERNMENT RESIDENT MANAGEMENT SYSTEM**

The Government will use computer software called Resident Management System for Windows (RMS) to assist in its monitoring and administration of this contract. The Contractor shall use the Government-furnished Construction Contractor Module of RMS, referred to as QCS, to record, maintain, and submit various information throughout the contract period. The use of QCS is covered by Section 01312, QUALITY CONTROL SYSTEM (QCS). QCS produces a majority of the forms required in this contract for submission to the Government. Some of these forms are shown as samples at the end of this section. They include ENG 4288 (Submittal Register), ENG 4025 (Transmittal form), CQC Daily Report, Definable Feature of Work Form, User Schooling Information Form, Quality Control Testing Information, Subcontractor Information Form, and Pay Activities and Activity Information.

***1**

1.43 TIME EXTENSIONS FOR UNUSUALLY SEVERE WEATHER. ER 415-1-15 (31 OCT 89)
2 January 1991

This provision specifies the procedure for the determination of time extensions for unusually severe weather in accordance with the contract clause entitled "Default: Fixed Price Construction)". In order for the Contracting Officer to award a time extension under this clause, the following conditions must be satisfied:

The weather experienced at the project site during the contract period must be found to be unusually severe, that is, more severe than the adverse weather anticipated for the project location during any given month.

The unusually severe weather must actually cause a delay to the completion of the project. The delay must be beyond the control and without the fault or negligence of the Contractor.

The following schedule of monthly anticipated adverse weather delays is based on National Oceanic and Atmospheric Administration (NOAA) or similar data for the project location and will constitute the base line for monthly weather time evaluations. The Contractor's progress schedule must reflect these anticipated adverse weather delays in all weather dependent activities.

MONTHLY ANTICIPATED ADVERSE WEATHER DELAY WORK DAYS
(BASED ON (5) DAY WORK WEEK)

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
(11)	(8)	(6)	(6)	(5)	(4)	(5)	(4)	(4)	(4)	(4)	(6)

MONTHLY ANTICIPATED ADVERSE WEATHER DELAY WORK DAYS
(BASED ON (6) DAY WORK WEEK)

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
(14)	(10)	(7)	(7)	(6)	(5)	(6)	(5)	(5)	(5)	(5)	(7)

MONTHLY ANTICIPATED ADVERSE WEATHER DELAY WORK DAYS
(BASED ON (7) DAY WORK WEEK)

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
(16)	(12)	(8)	(8)	(7)	(5)	(7)	(5)	(6)	(6)	(6)	(8)

Upon acknowledgment of the Notice to Proceed (NTP) and continuing throughout the contract, the Contractor will record on the daily CQC report, the occurrence of adverse weather and resultant impact to normally scheduled work. Actual adverse weather delay days must prevent work on critical activities for 50 percent or more of the Contractor's scheduled work day. The number of actual adverse weather delay days shall include days impacted by actual adverse weather (even if adverse weather occurred in previous month), be calculated chronologically from the first to the last day of each month, and be recorded as full days. If the number of actual adverse weather delay days exceeds the number of days anticipated listed above, the Contracting Officer will convert any qualifying delays to calendar days, giving full consideration for equivalent fair weather work days, and issue a modification in accordance with the contract clause entitled "Default (Fixed Price Construction)".

1.44 USE OF INCLINOMETER FOR LONG BED DUMP TRUCKS (DACF BULLETIN 25 MARCH 1993)
4 June 1993

The recommendation of EM 385-1-1, Section 16.B.15, is mandatory for this project.

1.45 AVAILABILITY OF SAFETY AND HEALTH REQUIREMENTS MANUAL (EM 385-1-1).
17 May 2000

As covered by CONTRACT CLAUSE "ACCIDENT PREVENTION", compliance with EM 385-1-1 is a requirement for this contract. Copies may be purchased for $31.00 each at the following address:

United States Government Bookstore
Room 118, Federal Building

1000 Liberty Avenue
Pittsburgh, PA 15222-4003
Telephone: (412) 395-5021 FAX: (412) 395-4547

Or downloaded from the following website:

http://www.usace.army.mil/inet/usace-docs/eng-manuals/em385-1-1/toc.htm

1.46 NOT USED (FIRE PROTECTION DURING CONSTRUCTION)

1.47 HAUL ROADS
2 Jan 1996

Whenever practical, one-way haul roads shall be used on this contract. Haul roads built and maintained for this work shall comply with the following:

a. One-way haul roads for off-the road equipment; e.g., belly dumps, scrapers, and off-the-road trucks shall have a minimum usable width of 25 ft. One-way haul roads for over-the-road haulage equipment only (e.g., dump trucks, etc.) may be reduced to a usable width of 15 ft. When the Contracting Officer determines that it is impractical to obtain the required width for one-way haul roads (e.g., a road on top of a levee), a usable width of not less than 10 ft. may be approved by the Contracting Officer, provided a positive means of traffic control is implemented. Such positive means shall be signs, signals, and/or signalman and an effective means of speed control.

b. Two-way haul roads for off-the-road haulage equipment shall have a usable width of 60 ft. Two-way haul roads for over-the-road haulage equipment only may be reduced to a usable width of 30 ft.

c. Haul roads shall be graded and otherwise maintained to keep the surface free from potholes, ruts, and similar conditions that could result in unsafe operation.

d. Grades and curves shall allow a minimum sight distance of 200 ft. for one-way roads and 300 ft. for two-way roads. Sight distance is defined as the centerline distance an equipment operator (4.5 ft. above the road surface) can see an object 4.5 ft. above the road surface. When conditions make it impractical to obtain the required sight distance (e.g., ramps over levees), a positive means of traffic control shall be implemented.

e. Dust abatement shall permit observation of objects on the roadway at a minimum distance of 300 ft.

f. Haul roads shall have the edges of the usable portion marked with posts at intervals of 50 ft. on curves and 200 ft. maximum elsewhere. Such markers shall extend 6 ft. above the road surface and, for nighttime haulage, be provided with reflectors in both directions.

1.48 NOT USED (RADIOACTIVE MATERIAL/EQUIPMENT)

1.49 NOT USED(CONSTRUCTION/SITE MANAGEMENT STANDARDS FOR CONSTRUCTION ON

AMC INSTALLATIONS)

1.50 CONSTRUCTION HAZARD COMMUNICATION
1 November 1991

The Contractor is required to comply with the requirements of the OSHA Hazard Communication Standard (29 CFR 1926.59). This standard is designed to inform workers of safe and appropriate methods of working with hazardous substances in the workplace. The standard has five requirements, and every hazardous or potentially hazardous substance used or stored in the work area is subject to all five. They are:

(1) Hazard Evaluation. Any company which produces or imports a chemical or compound must conduct a hazard evaluation of the substance to determine its potential health or physical hazard. The hazard evaluation consists of an investigation of all the available scientific evidence about the substance. The Contractor is required to assure that all producers (manufacturer/distributors) have performed these evaluations and transmit the required information with any hazardous materials being used or stored on the project site. From the hazard evaluation, a substance may be classified as a health hazard, or a physical hazard. These classifications are then further broken down according to type:

Health Hazards	Physical Hazards
Carcinogens	Combustible liquids
Irritants	Compressed gases
Sensitizers	Explosives
Corrosives	Flammables
Toxic substances	Organic peroxides
Highly toxic substances	Unstable substances
Substances harmful to specific organs or parts of the body	Water-reactive substances

(2) Warning Labels. If a chemical is hazardous or potentially hazardous, the producer or importer must affix a warning label to every container of that chemical before it leaves his facility. The Contractor must assure these labels are attached and legible. The label must identify the chemical, state the hazard, and give the name and address of the producer or importer. If the hazardous substance is transferred to another container, that container must then be labeled, tagged, or marked with the name of the chemical and the appropriate hazard warning. Warning labels should be replaced immediately if they are defaced or removed.

(3) Material Safety Data Sheets. The producer or importer must also supply a material safety data sheet (MSDS). The Contractor must keep these available in the work area where the substance is used, so that the people using the substance can easily review important safety and health information, such as:

The hazard possible from misuse of the substance
Precautions necessary for use, handling, and storage

Emergency procedures for leaks, spills, fire and first aid
Useful facts about the substance's physical or chemical properties

(4) Work Area Specific Training. Because of hazardous substance may react differently depending on how it is used or the environment of the work area, the Contractor must conduct work area specific training; special training which takes the Contractor's operations, environment, and work policies into consideration. Work area training presents:

The hazardous substances which are present in the work place and the hazards they pose

Ways to protect against those hazards, such as protective equipment, emergency procedures, and safe handling

Where the MSDS's are kept, and an explanation of the labeling system
Where the Contractor's written Hazard Communication Program is located

(5) The Written Hazard Communication Program. In accordance with OSHA requirements, the Contractor must prepare a written Hazard Communication Program. This document will be included in the Contractor's Accident Prevention Plan. This document states how the Contractor plans to ensure that hazardous materials are appropriately labeled, how and where MSDS's will be maintained, and how employees will be provided with specific information and training.

1.51 NOT USED(ENVIRONMENTAL PROTECTION CLAUSE TANK CLEANING AND PAINTING)

1.52 MECHANICAL ROOM LAYOUT (ORL).
24 FEBRUARY 1992

Detailed mechanical room layout drawings shall be submitted for approval in accordance with SD-04 Section 01335. Layout drawings shall show location and maintenance clearances for all mechanical room equipment, and all utility runs/chases for mechanical, electrical, telephone and other similar systems. Drawings shall be submitted at the same time as the submittals for the equipment to be located within the mechanical room.

1.53 RIGHTS IN TECHNICAL DATA--NONCOMMERCIAL ITEMS (NOV 1995)
252.227-7013 (JUN 1995).
20 March 1997

(a) Definitions. As used in this clause:

(1) "Computer data base" means a collection of data recorded in a form capable of being processed by a computer. The term does not include computer software.

(2) "Computer program" means a set of instructions, rules, or routines recorded in a form that is capable of causing a computer to perform a specific operation or series of operations.

(3) "Computer software" means computer programs, source code, source code listings, object code listings, design details, algorithms,

processes, flow charts, formulae and related material that would enable the software to be reproduced, recreated, or recompiled. Computer software does not include computer data bases or computer software documentation.

(4) "Computer software documentation" means owner's manuals, user's manuals, installation instructions, operating instructions, and other similar items, regardless of storage medium, that explain the capabilities of the computer software or provide instructions for using the software.

(5) "Detailed manufacturing or process data" means technical data that describe the steps, sequences, and conditions of manufacturing, processing or assembly used by the manufacturer to produce an item or component or to perform a process.

(6) "Developed" means that an item, component, or process exists and is workable. Thus, the item or component must have been constructed or the process practiced. Workability is generally established when the item, component, or process has been analyzed or tested sufficiently to demonstrate to reasonable people skilled in the applicable art that there is a high probability that it will operate as intended. Whether, how much, and what type of analysis or testing is required to establish workability depends on the nature of the item, component, or process, and the state of the art. To be considered "developed," the item, component, or process need not be at the stage where it could be offered for sale or sold on the commercial market, nor must the item, component, or process be actually reduced to practice within the meaning of Title 35 of the United States Code.

(7) "Developed exclusively at private expense" means development was accomplished entirely with costs charged to indirect cost pools, costs not allocated to a government contract, or any combination thereof.

(i) Private expense determinations should be made at the lowest practicable level.

(ii) Under fixed-priced contracts, when total costs are greater than the firm-fixed-price or ceiling price of the contract, the additional development costs necessary to complete development shall not be considered when determining whether development was at government, private, or mixed expense.

(8) "Developed exclusively with government funds" means development was not accomplished exclusively or partially at private expense.

(9) "Developed with mixed funding" means development was accomplished partially with costs charged to indirect cost pools and/or costs not allocated to a government contract, and partially with costs charged directly to a government contract.

(10) "Form, fit, and function data" means technical data that describes the required overall physical, functional, and performance characteristics (along with the qualification requirements, if applicable)

of an item, component, or process to the extent necessary to permit identification of physically and functionally interchangeable items.

(11) "Government purpose" means any activity in which the United States Government is a party, including cooperative agreements with international or multi-national defense organizations, or sales or transfers by the United States Government to foreign governments or international organizations. Government purposes include competitive procurement, but do not include the rights to use, modify, reproduce, release, perform, display, or disclose technical data for commercial purposes or authorize others to do so.

(12) "Government purpose rights" means the right to--

(i) Use, modify, reproduce, release, perform, display, or disclose technical data within the Government without restrictions; and

(ii) Release or disclose technical data outside the Government and authorize persons to whom release or disclosure has been made to use, modify, reproduce, release, perform, display, or disclose that data for United States government purposes.

(13) "Limited rights" means the rights to use, modify, reproduce, release, perform, display, or disclose technical data, in whole or in part, within the Government. The Government may not, without the written permission of the party asserting limited rights, release or disclose the technical data outside the Government, use the technical data for manufacture, or authorize the technical data to be used by another part, except that the Government may reproduce, release or disclose such data or authorize the use or reproduction of the data by persons outside the Government if reproduction, release, disclosure, or use is--

(i) Necessary for emergency repair and overhaul; or

(ii) A release or disclosure of technical data (other than detailed manufacturing or process data) to, or use of such data by, a foreign government that is in the interest of the Government and is required for evaluational or informational purposes;

(iii) Subject to a prohibition on the further reproduction, release, disclosure, or use of the technical data; and

(iv) The contractor or subcontractor asserting the restriction is notified of such reproduction, release, disclosure, or use.

(14) "Technical data" means recorded information, regardless of the form or method of the recording, of a scientific or technical nature (including computer software documentation). The term does not include computer software or data incidental to contract administration, such a financial and/or management information.

(15) "Unlimited rights" means rights to use, modify, reproduce, perform, display, release, or disclose technical data in whole or in part, in any manner, and for any purpose whatsoever, and to have or authorize

others to do so.

(b) Rights in technical data.

The Contractor grants or shall obtain for the Government the following royalty free, world-wide, nonexclusive, irrevocable license rights in technical data other than computer software documentation (see Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation clause of this contract for rights in computer software documentations):

(1) Unlimited rights.

The Government shall have unlimited rights in technical data that are--

(i) Data pertaining to an item, component, or process which has been or will be developed exclusively with Government funds;

(ii) Studies, analyses, test data, or similar data produced for this contract, when the study, analysis, test, or similar work was specified as an element of performance;

(iii) Created exclusively with Government funds in the performance of a contract that does not require the development, manufacture, construction, or production of items, components, or processes;

(iv) Form, fit, and function data;

(v) Necessary for installation, operation, maintenance, or training purposes (other than detailed manufacturing or process data);

(vi) Corrections or changes to technical data furnished to the Contractor by the Government;

(vii) Otherwise publicly available or have been released or disclosed by the Contractor or subcontractor without restrictions on further use, release or disclosure, other than a release or disclosure resulting from the sale, transfer, or other assignment of interest in the technical data to another party or the sale or transfer of some or all of a business entity or its assets to another party;

(viii) Data in which the Government has obtained unlimited rights under another Government contract or as a result of negotiations; or

(ix) Data furnished to the Government, under this or any other Government contract or subcontract thereunder, with--

(A) Government purpose license rights or limited rights and the restrictive condition(s) has/have expired; or

(B) Government purpose rights and the Contractor's exclusive right to use such data for commercial purposes has expired.

(2) Government purpose rights.

(i) The Government shall have government purpose rights for a five-year period, or such other period as may be negotiated, in technical data--

(A) That pertain to items, components, or processes developed with mixed funding except when the Government is entitled to unlimited rights in such data as provided in paragraphs (b)(ii) and (b)(iv) through (b)(ix) of this clause; or

(B) Created with mixed funding in the performance of a contract that does not require the development, manufacture, construction, or production of items, components, or processes.

(ii) The five-year period, or such other period as may have been negotiated, shall commence upon execution of the contract, subcontract, letter contract (or similar contractual instrument), contract modification, or option exercise that required development of the items, components, or processes or creation of the data described in paragraph (b)(2)(i)(B) of this clause. Upon expiration of the five-year or other negotiated period, the Government shall have unlimited rights in the technical data.

(iii) The Government shall not release or disclose technical data in which it has government purpose rights unless--

(A) Prior to release or disclosure, the intended recipient is subject to the non-disclosure agreement at 227.7103-7 of the Defense Federal Acquisition Regulation Supplement (DFARS); or

(B) The recipient is a Government contractor receiving access to the data for performance of a Government contract that contains the clause at DFARS 252.227-7025, Limitations on the Use or Disclosure of Government-Furnished Information Market with Restrictive Legends.

(iv) The Contractor has the exclusive right, including the right to license others, to use technical data in which the Government has obtained government purpose rights under this contract for any commercial purpose during the time period specified in the government purpose rights legend prescribed in paragraph (f)(2) of this clause.

(3) Limited rights.

(i) Except as provided in paragraphs (b)(1)(ii) and (b)(1)(iv) through (b)(1)(ix) of this clause, the Government shall have limited rights in technical data--

(A) Pertaining to items, components, or processes developed exclusively at private expense and marked with the limited rights legend prescribed in paragraph (f) of this clause; or

(B) Created exclusively at private expense in the performance of a contract that does not require the development, manufacture, construction, or production of items, components, or processes.

(ii) The Government shall require a recipient of limited rights data for emergency repair or overhaul to destroy the data and all copies in its possession promptly following completion f the emergency repair/overhaul and to notify the Contractor that the data have been destroyed.

(iii) The Contractor, its subcontractors, and suppliers are not required to provide the Government additional rights to use, modify, reproduce, release, perform, display, or disclose technical furnished to the Government with limited rights. However, if the Government desires to obtain additional rights in technical data in which it has limited rights, the Contractor agrees to promptly enter into negotiations with the Contracting Officer to determine whether there are acceptable terms for transferring such rights. All technical data in which the Contractor has granted the Government additional rights shall be listed or described in a license agreement made part of the contract. the license shall enumerate the additional rights granted the Government in such data.

(4) Specifically negotiated license rights.

The standard license rights granted to the Government under paragraphs (b)(1) through (b)(3) of this clause, including the period during which the Government shall have government purpose rights in technical data, may be modified by mutual agreement to provide such rights as the parties consider appropriate but shall not provide the Government lesser rights than are enumerated in paragraph (a)(13) of this clause. Any rights so negotiated shall be identified in a license agreement made part of this contract.

(5) Prior government rights.

Technical data that will be delivered, furnished, or otherwise provided to the Government under this contract, in which the Government has previously obtained rights shall be delivered, furnished, or provided with the pre-existing rights, unless--

(i) The parties have agreed otherwise; or

(ii) Any restrictions on the Government's rights to use, modify, reproduce, release, perform, display, or disclose the data have expired or no longer apply.

(6) Release from liability.

The Contractor agrees to release the Government from liability for any release or disclosure of technical data made in accordance with paragraph (a)(13) or (b)(2)(iii) of this clause, in accordance with the terms of a license negotiated under paragraph (b)(4) of this clause, or by others to whom the recipient has released or disclosed the data and to seek relief solely from the party who has improperly used, modified, reproduced, released, performed, displayed, or disclosed Contractor data marked with restrictive legends.

(c) Contractor rights in technical data.

All rights not granted to the Government are retained by the Contractor.

(d) Third party copyrighted data.

The Contractor shall not, without the written approval of the Contracting Officer, incorporate any copyrighted data in the technical data to be delivered under this contract unless the Contractor is the copyright owner or has obtained for the Government the license rights necessary to perfect a license or licenses in the deliverable data of the appropriate scope set forth in paragraph (b) of this clause, and has affixed a statement of the license or licenses obtained on behalf of the Government and other persons to the data transmittal document.

(e) Identification and delivery of data to be furnished with restrictions on use, release, or disclosure.

(1) This paragraph does not apply to restrictions based solely on copyright.

(2) Except as provided in paragraph (e)(3) of the clause, technical data that the Contractor assets should be furnished to the Government with restrictions on use, release, or disclosure are identified in an attachment to this contract (see Attachment). The Contractor shall not deliver any data with restrictive markings unless the data are listed on the Attachment.

(3) In addition to the assertions made in the Attachment, other assertions may be identified after award when based on new information or inadvertent omissions unless the inadvertent omissions would have materially affected the source selection decision. Such identification and assertion shall be submitted to the Contracting Officer as soon as practicable prior to the scheduled date for delivery of the data, in the following format, and signed by an official authorized to contractually obligate the Contractor:

Identification and Assertion of Restrictions on the Government's Use, Release, or Disclosure of Technical Data.

The Contractor asserts for itself, or the persons identified below, that the Government's rights to use, release, or disclose the following technical data should be restricted--

Technical Data to be Furnished With Restrictions*	Basis for Assertion**	Asserted Rights Category***	Name of Person Asserting Restrictions****
(LIST)	(LIST)	(LIST)	(LIST)

*If the assertion is applicable to items, components, or processes developed at private expense, identify both the data and each such item, component, or process.

**Generally, the development of an item, component, or process at private expense, either exclusively or partially, is the only basis for asserting restrictions on the Government's rights to use, release, or disclose technical data pertaining to such terms, components, or processes. Indicate whether development was exclusively or partially at private expense. If development was not at private expense, enter the specific reason for asserting that the Government's right should be restricted.

***Enter asserted rights category (e.g. government purpose license rights from a prior contract, rights in SBIR data generated under another contract, limited or government purpose rights under this or a prior contract, or specifically negotiated licenses).

****Corporation, individual, or other person, as appropriate.

Date ______________________________

Printed Name and Title ______________________________

____

Signature ______________________________

____

(End of identification and assertion)

(4) When requested by the Contracting Officer, the Contractor shall provide sufficient information to enable the Contracting Officer to evaluate the Contractor's assertions. The Contracting Officer reserves the right to add the Contractor's assertions to the Attachment and validate any listed assertion, at a later date, in accordance with the procedures of the Validation of Restrictive Markings on Technical Data clause of this contract.

(f) Marking requirements.

The Contractor, and its subcontractor or suppliers, may only assert restrictions on the Government's rights to use, modify, reproduce, release, perform, display, or disclose technical data to be delivered under this contract by marking the deliverable data subject to restriction. Except as provided in paragraph (f)(5) of this clause, only the following legends are authorized under this contract: the government purpose rights legend at paragraph (f)(2) of this clause: the limited rights legend at paragraph (f)(3) of this clause: or the special license rights legend at paragraph (f)(4) of this clause, and/or a notice of copyright as prescribed under 17 U.S.C. 401 or 402.

(1) General marking instructions.

The Contractor, or its subcontractors or suppliers, shall conspicuously and legibly mark the appropriate legend on all technical data that qualify for such markings. The authorized legends shall be placed on the transmittal document or storage container and, for printed material, each page of the printed material containing technical data for which restrictions are asserted. When only portions of a page of printed material are subject to the asserted restrictions, such portions shall be identified by circling, underscoring, with a note, or other appropriate identifier. Technical data transmitted directly from one computer or computer terminal to another shall contain a notice of asserted restrictions. Reproductions of technical data or any portions thereof subject to asserted restrictions shall also reproduce the asserted restrictions.

(2) Government purpose rights markings.

Data delivered or otherwise furnished to the Government with government purpose rights shall be marked as follows:

GOVERNMENT PURPOSE RIGHTS

Contract No. ______________________________________

Contractor Name ___________________________________

Contractor Address ________________________________

____

Expiration Date ___________________________________

The Government's rights to use, modify, reproduce, release, perform, display, or disclose these technical data are restricted by paragraph (b)(2) of the Rights in Technical Data--Noncommercial Items clause contained in the above identified contract. No restrictions apply after the expiration date shown above. Any reproduction of technical data or portions thereof marked with this legend must also reproduce the markings.

(End of legend)

(3) Limited rights markings.

Data delivered or otherwise furnished to the Government with limited rights shall be marked with the following legend:

LIMITED RIGHTS

Contract No. ______________________________________

Contractor Name ___________________________________

Contractor Address ________________________________

____

The Government's rights to use, modify, reproduce, release, perform, display, or disclose these technical data are restricted by paragraph (b)(3) of the Rights in Technical Data--Noncommercial Items clause contained in the above identified contract. Any reproduction of technical data or portions thereof marked with this legend must also reproduce the markings. Any person, other than the Government, who has been provided access to such data must promptly notify the above name Contractor.

(End of legend)

(4) Special license rights markings.

(I) Data in which the Government's rights stem from a specifically negotiated license shall be marked with the following legend:

SPECIAL LICENSE RIGHTS

The Government's rights to use, modify, reproduce, release, perform, display, or disclose these data are restricted by Contract No. _______)Insert contract number) ______, License No. ________ (Insert license identifier) _______. Any reproduction of technical data or portions thereof marked with this legend must also reproduce the markings.

(End of legend)

(ii) For purposes of this clause, special licenses do not include government purpose license rights acquired under a prior contract (see paragraph (b)(5) of this clause)_.

(5) Pre-existing data markings.

If the terms of a prior contract or license permitted the Contractor to restrict the Government's rights to use, modify, reproduce, release perform, display, or disclose technical data deliverable under this contract, and those restrictions are still applicable, the Contractor may mark such data with the appropriate restrictive legend for which the data qualified under the prior contract or license. The marking procedures in paragraph (f)(1) of this clause shall be followed.

(g) Contractor procedures and records.

Throughout performance of this contract, the Contractor and its subcontractors or suppliers that will deliver technical data with other than unlimited rights, shall--

(1) Have, maintain, and follow written procedures sufficient to assure that restrictive markings are used only when authorized by the terms of this clause, and

(2) Maintain records sufficient to justify the validity of any restrictive markings on technical data delivered under this contract.

(h) Removal of unjustified and nonconforming markings.

(1) Unjustified technical data markings.

The rights and obligations of the parties regarding the validation of restrictive markings or technical data furnished or to be furnished under this contract are contained in the Validation of Restrictive Markings on Technical Data clause of this contract. Notwithstanding any provision of this contract concerning inspection and acceptance, the Government may ignore or, at the Contractor's expense, correct or strike a marking if, in accordance with the procedures in the Validation of Restrictive Markings on Technical Data clause of this contract, a restrictive marking is determined to be unjustified.

(2) Nonconforming technical data markings.

A nonconforming marking is a marking placed on technical data delivered or otherwise furnished to the Government under this contract that is not in the format authorized by this contract. Correction of nonconforming markings is not subject to the Validation of Restrictive Markings on Technical Data clause of this contract. If the Contracting Officer notifies the Contractor of a nonconforming marking and the Contractor fails to remove or correct such marking within sixty (60) days, the Government may ignore or, at the Contractor's expense, remove or correct any nonconforming marking.

(I) Relation to patents.

Nothing contained in this clause shall imply a license to the Government under any patent or be construed as affecting the scope of any license or other with otherwise granted to the Government under any patent.

(j) Limitation on charges for rights in technical data.

(1) The Contractor shall not charge to this contract any cost, including, but not limited to, license fees, royalties, or similar charges, for rights in technical data to be delivered under this contract when--

(I) The Government has acquired, by any means, the same or greater rights in the data; or

(ii) The data are available to the public without restrictions.

(2) The limitation in paragraph (j)(1) of this clause--

(I) Includes costs charged by a subcontractor or supplier, at any tier, or costs incurred by the Contractor to acquire rights in subcontractor or supplier technical data, if the subcontractor or supplier has been paid for such rights under any other Government contract or under a license conveying the rights to the Government; and

(ii) Does not include the reasonable costs of reproducing, handling, or mailing the documents or other media in which the technical data will be delivered.

(k) Applicability to subcontractors or suppliers.

(1) The Contractor shall ensure that the rights afforded its subcontractors and suppliers under 10 U.S.C. 2320, 10 U.S.C. 2321, and the identification, assertion, and delivery processes of paragraph (e) of this clause are recognized and protected.

(2) Whenever any technical data for noncommercial items is to be obtained from a subcontractor or supplier for delivery to the Government under this contract, the Contractor shall use this same clause in the subcontract or other contractual instrument, and require its subcontractors or suppliers to do so, without alteration, except to identify the parties. No other clause shall be used to enlarge or diminish the Government's, the Contractor's, or a higher-tier subcontractor's or supplier's rights in a subcontractor's or supplier's technical data.

(3) Technical data required to be delivered by a subcontractor or supplier shall normally be delivered to the next higher-tier contractor, subcontractor, or supplier. However, when there is a requirement in the prime contract for data which may be submitted with other than unlimited rights by a subcontractor or supplier, then said subcontractor or supplier may fulfill its requirement by submitting such data directly to the Government, rather than through a higher-tier contractor, subcontractor, or supplier.

(4) The Contractor and higher-tier subcontractors or suppliers shall not use their power to award contracts as economic leverage to obtain rights in technical data from their subcontractors or suppliers.

(5) In no event shall the Contractor use its obligation to recognize and protect subcontractor or supplier rights in technical data as an excuse for failing to satisfy its contractual obligation to the Government.

1.54 LIMITATIONS ON THE USE OR DISCLOSURE OF GOVERNMENT-FURNISHED INFORMATION MARKED WITH RESTRICTIVE LEGEND DFARS 252.227-7025 (JUN 1995)
2 January 1996

(a)(1) For contracts requiring the delivery of technical data, the terms, "limited rights" and "Government purpose rights" are defined in the Rights in Technical Data--Noncommercial Items clause of this contract.

(2) For contracts that do not require the delivery of technical data, the terms "government purpose rights" and "restricted rights" are defined in the Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation clause of this contract.

(3) For Small Business Innovative Research program contracts, the terms "limited rights" and "restricted rights" are defined in the Rights in Noncommercial Technical Data and Computer Software--Small Business Innovative Research (SBIR) Program clause of this contract.

(b) Technical data or computer software provided to the Contractor as Government furnished information (GFI) under this contract may be subject to restrictions on use, modification, reproduction, release, performance, display, or further disclosure.

(1) GFI marked with limited or restricted rights legends.

The Contractor shall use, modify, reproduce, perform, or display technical data received from the Government with limited rights legends or computer software received with restricted rights legends only in the performance of this contract. The Contractor shall not, without the express written permission of the party whose name appears in the legend, release or disclose such data or software to any person.

(2) GFI marked with government purpose rights legends.

The Contractor shall use technical data or computer software received from the Government with government purpose rights legends for government purposes only. The Contractor shall not, without the express written permission of the party whose name appears in the restrictive legend, use, modify, reproduce, release, perform, or display such data or software for any commercial purpose or disclose such data or software to a person other than its subcontractors, suppliers, or prospective subcontractors or suppliers, who require the data or software to submit offers for, or perform, contracts under this contract. Prior to disclosing the data or software, the Contractor shall require the persons to whom disclosure will be made to complete and sign the non-disclosure agreement at 227.7103-7 of the Defense Federal Acquisition Regulation Supplement (DFARS).

(3) GFI marked with specially negotiated license rights legends.

The Contractor shall use, modify, reproduce, release, perform, or display technical data or computer software received from the Government with specially negotiated license legends only as permitted in the license. Such data or software may not be release or disclosed to other persons unless permitted by the license and, prior to release or disclosure, the intended recipient has completed the non-disclosure agreement at DFARS 227.7103-7. The Contractor shall modify paragraph (1)(c) of the non-disclosure agreement to reflect the recipient's obligations regarding use, modification, reproduction, release, performance, display, and disclosure of the data of software.

(c) Indemnification and creation of third party beneficiary rights.

The Contractor agrees--

(1) To indemnify and hold harmless the Government, its agents, and employees from every claim or liability, including attorneys fees, court costs, and expenses, arising out of, or in any way related to, the misuse or unauthorized modification, reproduction, release, performance, display, or disclosure of technical data or computer software received from the Government with restrictive legends by the Contractor or any person to whom the Contractor has released or disclosed such data or software; and

(2) That the party whose name appears on the restrictive legend, in addition to any other rights it may have, is a third party beneficiary who

has the right of direct action against the Contractor, or any person to whom the Contractor has released or disclosed such data or software, for the unauthorized duplication, release, or disclosure of technical data or computer software subject to restrictive legends.

1.55 NOT USED (FIRMR APPLICABILITY)

1.56 VARIATIONS IN ESTIMATED QUANTITIES - SUBDIVIDED ITEMS (MAR 1995)
EFARS 52.212-5001.
2 Jan 1996

***3 *2**

This variation in Estimated Quantities clause is applicable only to Items Nos. **0051/0051AA, 0052/0052AA, 0053/0053AA, 0054/0054AA, 0055/0055AA, 0056/0056AA, 0080/0080AA, 0081/0081AA, 0091/0091AA, and 0092/0092AA**.

(a) Variation from the estimated quantity in the actual work performed under any second or subsequent sub-item or elimination of all work under such a second or subsequent sub-item will not be the basis for an adjustment in contract unit price.

(b) Where the actual quantity of work performed for Items Nos. **0051, 0052, 0053, 0054, 0055, 0056, 0080, 0081, 0091, and 0092 is** less than 85% of the quantity of the first sub-item listed under such item, the contractor will be paid at the contract unit price for that sub-item for the actual quantity of work performed and, in addition, an equitable adjustment shall be made in accordance with the clause FAR 52.212-11, Variation in Estimated Quantities.

(c) **If the quantity of work performed under Items Nos. 0051, 0052, 0053, 0054, 0055, 0056, 0080, 0081, 0091, and 0092 is less than 85% or exceeds 115% of the total estimated quantity of the sub-items under that item, and if such variation causes an increase or a decrease in the time required for performance of this contract the contract completion time will be adjusted in accordance with the clause FAR 52.212-11, Variation in Estimated Quantities.**

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1.57 PARTNERING
August 1996

In order to most effectively accomplish this contract, the Government proposes to form a partnership with the Contractor to develop a cohesive building team. It is anticipated that this partnership would involve the Corps of Engineers, the Contractor, and key representatives to include subcontractors, the designers, and local community representatives. This partnership would strive to develop a cooperative management team drawing on the strengths of each team member in an effort to achieve a quality project within budget and on schedule. This partnership would be bilateral in membership and participation will be totally voluntary. It is anticipated that partnering meetings would be held every 6 months at a minimum. All costs, excluding labor and travel expenses, shall be shared equally between the Government and the Contractor. The Contractor and Government shall be responsible for their own labor and travel costs.

1.58 NOT USED

1.59 NOT USED (CONSTRUCTION AND DEMOLITION (C&D) WASTE MANAGEMENT PLAN)

Refer to SECTION 01410, ENVIRONMENT PROTECTION for CDD waste management requirements.

1.60 DAMAGE TO WORK (ORL)
15 JUNE 1990

The responsibility for damage to any part of the work to be performed under this contract shall be as set forth in the CONTRACT CLAUSE: PERMITS AND RESPONSIBILITIES. However, if in the judgement of the Contracting Officer, any part of the permanent work performed by the Contractor is damaged by flood or earthquake or the cofferdam is overtopped by flood and such flood causes damage to the cofferdam, which damage is not due to the failure of the Contractor to take reasonable precaution or to exercise sound engineering and construction practices in the conduct of the work, the Contractor will make the repairs ordered by the Contracting Officer and full compensation for such repairs will be made at the applicable contract unit or lump sum prices as fixed and established in the contract. If, in the opinion of the Contracting Officer, there are no contract unit or lump sum prices applicable to any part of such damaged work, an equitable adjustment pursuant to CONTRACT CLAUSE: CHANGES will be made as full compensation therefor.

The Contractor may, subject to the approval of the Contracting Officer, or the Contracting Officer may order the Contractor to flood or breach the cofferdam during a rise prior to, and in anticipation of, natural flooding due to overtopping. Such flooding or breach will be considered the same as though the cofferdam, if constructed in accordance with plans and progress schedules approved by the Contracting Officer, had been overtopped, in which event an equitable adjustment will be made for damages to the cofferdam and/or any part of the permanent work, as provided in the paragraph above.

1.61 CONTINUING CONTRACTS (MAR 1995) EFARS 52.232-5001.
2 January 1996

a. This is a continuing contract, as authorized by Section 10 of the River and Harbor Act of September 22, 1922 (33 U.S. Code 621). The payment of some portion of the contract price is dependent upon reservations of funds from future appropriations, and from future contribution to the project having one or more non-federal project sponsors. The responsibilities of the Government are limited by this clause notwithstanding any contrary provision of the "Payments to Contractor" clause or any other clause of this contract.

b. The sum of $1,000,000 has been reserved for this contract and is available for payments to the Contractor during the current fiscal year. It is expected that Congress will make appropriations for future fiscal years from which additional funds together with funds provided by one or more non-federal project sponsors will be reserved for this contract.

c. Failure to make payments in excess of the amount currently reserved, or that may be reserved from time to time, shall not entitle the Contractor to a price adjustment under the terms of this contract except as specifically provided in paragraphs 24.6 and 24.9 below. No such failure shall constitute a breach of this contract, except that this provision shall not bar a breach-of-contract action if an amount finally determined to be due as a termination allowance remains unpaid for one year due solely to a failure to reserve sufficient additional funds therefore.

d. The Government may at any time reserve additional funds for payments under the contract if there are funds available for such purpose. The Contracting Officer will promptly notify the Contractor of any additional funds reserved for the contract by issuing an administrative modification to the contract.

e. If earnings will be such that funds reserved for the contract will be exhausted before the end of any fiscal year, the Contractor shall give written notice to the Contracting Officer of the estimated date of exhaustion and the amount of additional funds which will be needed to meet payments due or to become due under the contract during that fiscal year. This notice shall be given not less than 45 nor more than 60 days prior to the estimated date of exhaustion.

f. No payments will be made after exhaustion of funds except to the extent that additional funds are reserved for the contract. The Contractor shall be entitled to simple interest on any payment that the Contracting Officer determines was actually earned under the terms of the contract and would have been made except for exhaustion of funds. Interest shall be computed from the time such payment would otherwise have been made until actually or constructively made, and shall be at the rate established by the Secretary of the Treasury pursuant to Public Law 92-41, 85 STAT 97, as in effect on the first day of the delay in such payment.

g. Any suspension, delay, or interruption of work arising from exhaustion or anticipated exhaustion of funds shall not constitute a breach of this contract and shall not entitle the Contractor to any price adjustment under CONTRACT CLAUSE: SUSPENSION OF WORK or in any other manner under this contract.

h. An equitable adjustment in performance time shall be made for any increase in the time required for performance of any part of the work arising from exhaustion of funds or the reasonable anticipation of exhaustion of funds.

i. If, upon the expiration of 60 days after the beginning of the fiscal year following an exhaustion of funds, the Government has failed to reserve sufficient additional funds to cover payments otherwise due, the Contractor, by written notice delivered to the Contracting Officer at any time before such additional funds are reserved, may elect to treat his right to proceed with the work as having been terminated. Such a termination shall be considered a termination for the convenience of the Government.

j. If at any time it becomes apparent that the funds reserved for any fiscal year are in excess of the funds required to meet all payments due or to become due the Contractor because of work performed and to be performed under the contract during the fiscal year, the Government reserves the right, after notice to the Contractor, to reduce said reservation by the amount of such excess.

1.62 OBSTRUCTION OF NAVIGABLE WATERWAYS (DEC 1991) DFARS 252.236-7002.
24 February 1992

a. The Contractor shall--

(1) Promptly recover and remove any material, plant, machinery, or appliance which the Contractor loses, dumps, throws overboard, sinks, or misplaces, and which, in the opinion of the Contracting Officer, may be dangerous to or obstruct navigation;

(2) Give immediate notice, with description and locations of any such obstructions until the same are removed.

(3) When required by the Contracting Officer, mark or buoy such obstructions until the same are removed.

b. The Contracting Officer may--

(1) Remove the obstructions by contract or otherwise should the Contractor refuse, neglect, or delay compliance with paragraph a. above of this clause; and

(2) Deduct the cost of removal from any monies due or to become due to the Contractor; or

(3) Recover the cost of removal under the Contractor's bond.

c. The Contractor's liability for the removal of a vessel wrecked or sunk without fault or negligence in limited to that provided in Sections 15, 19, and 20 of River and Harbor Act of March 3, 1899 (33 U.S.C. 410 et.seq.).

d. The Government will maintain normal lock operations at McAlpine Locks during the contract period. The Contractor shall not obstruct navigation through the 1200-foot lock at any time. Over the last 10 years, the 1200-foot lock has been operated an average of 20 times per day. Contractor vessels will not have priority over commercial traffic in lock operations.

e. Within 30 days of Notice to Proceed, the Contractor shall submit to the Contracting Officer for approval his plan for maintaining normal navigation at McAlpine Locks. The plan shall describe all measures to be taken by the Contractor to ensure that construction activities do not obstruct navigation.

f. The Contractor shall provide a helper boat to aid navigation at the downstream approach of the 1200-foot lock during the demolition of downstream cofferdam cells (to include the removal of the entire cell, cell fill, and berm material) no. 9.5, 10, 11, and 12, and the connecting arcs between cells 10 and 11 and cells 11 and 12. The helper boat will be required 24 hours a day until this portion of the demolition is complete. The helper boat shall have a minimum of 800 horsepower. No separate payment shall be made for this work. All costs for this work shall be a subsidiary obligation of the contractor.

1.63 SIGNAL LIGHTS
15 June 1990

The Contractor shall display signal lights and conduct his operations in accordance with the General Regulations of the Department of the Army and of the Coast Guard governing lights and day signals to be displayed by towing vessels with tows on which no signals can be displayed, vessels working on wrecks, dredges and vessels engaged in laying cables or pipe or in submarine or bank protection operations, lights to be displayed on dredge pipe lines, and day signals to be displayed by vessels of more than 65 feet in length moored or anchored in a fairway or channel, and the passing by other vessels of floating plant working in navigable channels, as set forth in Commandant U.S. Coast Guard Instruction M16672.2, Navigation Rules: International-Inland (Comdtinst M16672.2), or 33 CFR81 Appendix A (International) and 33 CFR 84 through 33 CFR 89 (Inland) as applicable.

1.64 NOT USED (LAKE OPERATION)

1.65 NOT USED (PROPOSED BETTERMENTS)

1.66 NOT USED (SEQUENCE OF DESIGN/CONSTRUCTION)

1.67 NOT USED (SEQUENCE OF DESIGN/CONSTRUCTION)

1.68 NOT USED (DESIGN RESPONSIBILITY OF THE DESIGN/BUILD CONTRACTOR)

1.69 NOT USED (KEY PERSONNEL, SUBCONTRACTORS AND OUTSIDE ASSOCIATES OR CONSULTANTS)

1.70 NOT USED (REQUIREMENTS FOR REGISTRATION OF DESIGNERS)

1.71 NOT USED(DESIGN/BUILD CONTRACT - ORDER OF PRECEDENCE)

1.72 NOT USED (DESIGN CONFERENCES)

1.73 POLLUTION PREVENTION PLAN

In accordance with the Kentucky Pollutant Discharge Elimination System (KPDES) permit, a Storm Water Pollution Prevention Plan (SWPPP) has been developed for this project. This plan has been developed to meet the erosion and sediment control requirements for the Commonwealth of Kentucky. The SWPPP will be provided to the Contractor as a seperate document for use by any State inspectors. The Contractor will implement the SWPPP as shown on the plans, and as directed in these specifications. A Notice of Intent (NOI) will be prepared by the U. S. Army Corps of Engineers and submitted to the Commonwealth of Kentucky. Commencement of any construction activity (ground disturbing activity) by the Contractor shall not begin until 48 hours after the NOI has been postmarked. The Contractor shall maintain copies of the KPDES permit and SWPPP in the construction trailer on site. Any changes made to the SWPPP must be documented and approved by the Contracting Officer. The Contractor shall refer also to Sections 01356 Storm Water Pollution Prevention Measures and 01410 Environment Protection for additional requirements pertaining to KPDES and storm water pollution prevention requirements. Upon project completion, A Notice of Termination (NOT) will be prepared by the U. S. Army Corps of Engineers and submitted to the Commonwealth of Kentucky.

1.74 WORK COORDINATION

It will be necessary to closely coordinate Contractor work and local operations with the Corps of Engineers, the public, LG&E Hydropower Plant personnel, and other Corps of Engineers contractors. The Contractor shall participate in local information and coordination conferences to outline on-going and projected work. The frequency of these meetings will be determined by the Contracting Officer dependent on the scope and complexity of work, types of local operations, and potential impacts. As a minimum, these coordination meetings will be held weekly. The Contractor's Representative shall be sufficiently knowledgeable of the overall project work and scheduling of the prime and subcontractors' work to participate effectively in these meetings. Any agreements with other contractors shall be subject to the conditions of both contractors and to Government approval. Any activity which may impact others shall be fully coordinated, and additional work as necessary shall be performed to avoid impact.

1.75 INDEFINITE QUANTITIES

The quantities for the Bid Items entitled "Flooding Lost Time" and "Allowance for Flooding and Evacuation" are indefinite quantities. The indicated quantities will be used for bid evaluation purposes only. Quantities paid for will be determined in the event flood emergencies occur. The Government makes no representation as to the quantity required, and no minimum or maximum quantities are guaranteed. The quantities indicated are not subject to adjustment due to the over run, under run, or non-use. No payment will be made for the Bid Items listed above unless a flood emergency necessitates the specified implementing directives.

1.76 SAFETY ENGINEER REQUIREMENT

The Contractor shall identify a full time Safety Engineer for each shift on this project, and their qualifications must be submitted to the Government for acceptance. These individuals shall be employed by the prime contractor, be members of the onsite work organization and be responsible for overall management of the safety and occupational health program, with authority to act in all safety matters for the Contractor. Copies of the letters to the Safety Engineers signed by an authorized official of the firm describing responsibilities and delegating authority to stop work when safety or occupational health of workers is compromised must be provided to the Government as part of the Accident Prevention Plan. The Safety Engineers shall be individuals having 10 years of previous construction safety experience and shall be assigned no other duties. The Contractor must show evidence that these individuals have completed OSHA training, and are trained in First Aid and CPR. An alternate for each Safety Engineer shall be identified in the event of a Safety Engineer's absence. The qualifications for the alternate shall be similar as for the Safety Engineer and accepted by the Contracting Officer.

Acceptance of the Contractor's Safety Engineers is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during construction. The Government reserves the right to require the Contractor to make changes to operations including removal of personnel, as necessary, to obtain a safe work site. At no time will the job be permitted to operate without a full time Safety Engineer on duty at the work site.

Duties of the Safety Engineers shall include, as a minimum, the following: prepare the contractor's Accident Prevention Plan and Activity Hazard Analysis for each definable feature of work; provide safety indoctrination to all construction workers and site visitors to include personnel performing maintenance of equipment; ensure the Contractor's accepted Accident Prevention Plan is carried out; ensure that all contractor/ subcontractor employees have all HTRW, asbestos, and lead paint training as appropriate, and that their personnel protection equipment meets applicable OSHA/ EPA requirements; conduct daily walk through of the site ensuring work is being accomplished safely and occupational health is not compromised; attend and participate in all preparatory and initial quality control phase meetings; conduct weekly safety meetings for all workers; conduct monthly supervisory safety meetings; provide accident reports; produce a Daily Safety Report of activities performed and attach this report to the Contractor's Quality Control Report. Minutes shall be provided of weekly and monthly safety meetings with the Daily Safety Report.

1.77 SAFETY INCENTIVE CLAUSE

The Contractor shall provide a plan to encourage all employees to work safely. This plan shall be directed at the individual employee and shall be so designed such that it motivates all employees toward a safe work attitude. The plan shall be designed to be a positive incentive plan and must include a tangible reward and benefit to the individual employee during the physical, construction work on site. The reward frequency shall be at least once a month. This "Work Safety Incentive Plan" must be integrated into the overall "Accident Prevention Plan" which must be approved prior to start of construction. The "Work Safety Incentive Plan" shall indicate who will administer the program and provide discrete details on how it will be administered.

1.78 COFFERDAM EVACUATION REQUIREMENTS

Prior to commencing work in the dewatered cofferdam area, the Contractor shall implement the approved evacuation plan. The Contractor shall submit to the Contracting Officer for approval his plan for evacuation of the dewatered cofferdam area. The plan shall include circumstances under which the system would be activated, plan for activation, etc. The plan shall be in accordance with the requirements of EM 385-1-1. The plan shall contain the following in addition to the requirements of EM 385-1-1:

(a) Chain of supervision for evacuation activities.
(b) Method for accountability of personnel.
(c) Means for notifying personnel unable to hear alarm horns.
(d) Means for activating alarm and station locations.
(e) Emergency egress routes.
The system shall include, as a minimum, the following items:

a. Emergency Alarm System. The system provided as Government-furnished property provides manual stations for activating the alarm, both in the work area and on top of the cofferdam. The alarm system shall be operated and maintained by the Contractor. The Contractor shall ensure that the alarm provides a distinctive sound audible above the highest anticipated background noise, including heavy equipment operations, throughout the work area within the cofferdam area. The alarm shall be activated for a test both from the work area and from the top of the cofferdam once each month. A provision of the evacuation plan shall include a means for alerting personnel who are unable to hear the alarm.

b. Radio and Powered Megaphones. There shall be adequate radio communications between supervisors both within and outside of the cofferdam area, and in addition, with each work crew and crane operator. Powered megaphones (bullhorns) shall be provided and shall be available (one at each stairway) to relay verbal instructions to workmen within the area.

c. Personnel Stairs and Ladders. Stairs extending from the top of the cofferdam to the working floor are provided. The stair towers are to be used for emergencies only. Landings at the top and at the bottom of the stairs, and intermediate landings, shall be kept free from debris and be well lighted. Adequate stair ramps with guardrails shall be provided on steep slopes and/or loose material where required for safe egress from excavations. Each cofferdam exit stairway shall be kept open until the cofferdam is rewatered. When construction activities interfere with the location of a stairway, the Contractor shall maintain an exit way at the same general location, either around or up and over the construction activity in a manner that maintains the current distance between exit ways at all times during construction. The number and spacing of the stairtowers along the 600 south wall shall remain as shown and will require modification to remain in service during construction of the new 1200-foot lock south wall. All stairtowers and ramps shall be in accordance with EM 385-1-1. The Contractor's plan for altering any exit ways due to construction interference shall be submitted for Government Approval.

d. Skiffs. Two safety skiffs meeting requirements of EM 385-1-1 shall be required within the cofferdam area for emergency use.

e. Life Rings. Life rings shall be placed and maintained 100 feet apart on the outside of the cofferdam and inside near exits and work areas.

f. Lights. Proper lighting shall be provided of exit areas when night work is performed.

g. General. All of the above items shall be checked periodically to assure that they are in good working order. The period of all inspections shall be included in the evacuation plan and a means of documentation of inspections shall be included. All employees shall be instructed in the emergency escape routes, procedures, and signals to be used. Emergency signals should be understood prior to beginning site work and should be distinct from ordinary communication signals. When changing conditions warrant, instructions shall be given as required to keep all personnel current. Additional details concerning the cofferdam can be found in specification section 02170 COFFERDAM.

1.79 LIGHTNING DETECTION SYSTEM

The Contractor shall provide and install a lightning detection system for use during the course of construction for the project. The system shall be capable of monitoring actual strikes up to a minimum of 100 miles away and shall be able to detect strikes and sound an alarm when lightning is detected in the local area. The alarm shall be audible to all workers on the site. The Contractor shall develop a plan for seeking shelter and resuming work in case of an alarm. The plan shall also describe the location of the detector, local alarm distance, local alarm clear distance, and shelter location. This plan shall be incorporated into the Contractor's Accident Prevention Plan, and submitted for Government Approval.

1.80 PUBLIC MEETINGS

The Contractor's senior person on site will be required to participate in public meetings once a month. The Contractor's blaster in charge and seismic specialist will be required to participate in the public meetings once a month during the time periods when there is blasting taking place on the project. Representatives of the Corps of Engineers will also be present at these public meetings.

1.81 ADDITIONAL SAFETY REQUIREMENTS

Welding and hot work is prohibited within 100 feet of a red flag barge. Any welding or hot work occurring on a lock wall shall cease when a red flag barge enters the lock chamber and shall not commence until the barge has completely exited the lock chamber.

1.82 INSPECTION FACILITIES

In order ro facilitate inspection, the Contractor will be required, without additional cost, to furnish the following items:

(a) To furnish, on the request of the Contracting Officer or Government inspector, the use of such boats, boatmen, scales, equipment and crew of the plant as may be reasonably necessary in inspecting and supervising the work.

(b) To furnish, on the request of the Contracting Officer or Government inspector, suitable transportation from all points on shore designated by the Contracting Officer to and from various pieces of the plant.

Should the Contractor refuse, neglect, or delay compliance with these requirements, the specific facilities may be furnished and maintained by the Contracting Officer, and the cost therefore will be deducted from any amount due or become due to the Contractor.

1.83 PRESERVATION AND RECOVERY OF HISTORICAL, ARCHAEOLOGICAL, AND CULTURAL RESOURCES

District personnel have appropriately addressed known historical, archaeological and cultural resources discovered within the Contractor's work area. There are currently no known areas of cultural resource concern that need to be identified for the Contractor. If, however, during construction activities the Contractor observes unusual areas or items that might have historical or archaeological importance, work should stop in this area and the Contracting Officer should immediately be notified. The Contracting Officer will evaluate such observations as soon as practicable. Guidelines for recording and preservation of historical and archaeological finds during construction activities are specified in 36 CFR 800.

1.84 SCHEDULED PRE-PROPOSAL SITE VISIT MEETING

- The Pre-proposal Site Meeting scheduled for 17 April 2002 will begin at the Louisville Repair Station training room on Shippingport Island at 8:00 a.m. A short presentation and sign-in will be followed by a tour of the site. People interested in visiting the site must RSVP to the McAlpine Resident Engineer Office at (502)772-3492. It should be noted that the tour will be conducted on foot and will last approximately two hours. **Hard hats, safety shoes, and safety glasses must be worn at all times during the tour and should be brought by the Contractor.** Contractors are requested to submit (in writing) any anticipated questions during the 8:00 a.m. sign-in to help facilitate answers at the 11:00 meeting. The Pre-proposal Site Meeting will be followed by a Networking & Marketing Opportunity Program, which will be held at the Romano L. Mazzoli Federal Building Cafeteria from 1:00 to 4:00 p.m. An agenda for the Pre-proposal Site Meeting follows.

AGENDA FOR PRE-PROPOSAL SITE MEETING

8:00	Meet at Louisville Repair Station Training Room
9:00	Tour of Site
11:00	Meet at Louisville Repair Station Training Room for Briefing/Q&A
12:00	Adjourn

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1.85 FIELD OFFICE OVERHEAD

a. Field Office Overhead Percentage Markup. If any change to the contract,

issued pursuant to the Changes Clause or otherwise, for which the Government is responsible, causes an increase or decrease in the Contractor's cost of, or the time required for, performance under the contract, the Contracting Officer shall make an equitable adjustment and modify the contract in writing.

Under such equitable adjustment, no per diem rate for field office overhead shall be allowed if the Contractor has elected a percentage markup in keeping with its standard accounting practices. In such a case, payment of field office overhead shall be allowed for any change on a percentage markup basis regardless of whether the completion of the contract is or is not extended by reason of the change, except for modifications issued pursuant to the Default Clause. The Contractor shall provide a detailed breakdown of its proposed increase or decrease of costs as required by Contract Clause DFARS 252.236-7000 MODIFICATION OF PROPOSALS - PRICE BREAKDOWN.

b. Field Office Overhead Per Diem Rate. If any change to the contract, issued pursuant to the Changes Clause or otherwise, for which the Government is responsible, causes an increase or decrease in the Contractor's cost of, or the time required for, performance under the contract, the Contracting Officer shall make an equitable adjustment and modify the contract in writing.

Under such equitable adjustment, no payment of field office overhead shall be allowed for any changes when the completion of the contract is not extended by reason of the change, except the Contractor may be reimbursed any variable expense it incurs due to the change, provided it can substantiate the variables. The Contractor shall be reimbursed for field office overhead on a per diem basis when the completion of the contract is extended by reason of the change issued under any clause except the Default Clause. Equitable adjustment shall be made for the costs that are incurred or are to be incurred due to the change. The Contractor shall provide a detailed breakdown of its proposed increase or decrease of costs as required by Contract Clause DFARS 252.236-7000 MODIFICATION OF PROPOSALS - PRICE BREAKDOWN.

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1.86 SEA TRIALS FOR FINAL OPERATIONAL ACCEPTANCE

The Contractor shall conduct "SEA TRIALS" to test and prove the systems, components, and accessories required for the proper operation of the lock, as a completed whole, under operational conditions. The Contractor shall conduct the SEA TRIALS after all systems, both manually and/or computer operated, required for the proper operation of the lock and its accessories, have been completed and tested in accordance with the Technical Provisions of the contract, including any requirements under the "Inspection" clause. Any and all Contractor costs for the SEA TRIALS and all associated requirements, whether specifically noted below or not, shall be considered subsidiary to the contract price and no separate payment shall be provided. The Locks, as a structure and an operational facility, will be considered incomplete and unusable until completion of the SEA TRIALS. The Contractor shall remain fully responsible for the lock and appurtenances under the "Permits and Responsibilities" clause of the

contract, throughout the SEA TRIALS and until final acceptance.

Final acceptance will not occur until after the SEA TRIALS have been successfully completed in accordance with this paragraph and the Contractor's approved Plan, as described below.

The SEA TRIALS shall include, but not be limited to, the testing and proving of each of the following systems of the Lock:

Electrical Distribution System
Emergency Generator System
Hydraulic Systems
Compressed Air Systems
Raw Water Systems
Programmable Logic Control Systems
Computer Systems (including integration of existing systems)
Miter Gates, Latches, and Controls
Culvert Valves and Controls
Mooring Devices
Monitoring Systems
Lock Instrumentation Systems
Traffic Control Signals and Devices
Warning Sirens
Sump Systems and Alarms
Communications Systems
Closed-Circuit Television (CCTV) Systems
Lighting Systems and Controls
Heating and Cooling Systems

The following Bid Items have been identified as having systems to be tested during the SEA TRIALS:

0066 Miter Gates
0067 Culvert Valves & Maintenance Bulkheads
0068 Floating Mooring Bitts
0069 Instrumentation
0070 Hydraulic Power Systems
0071 Raw Water Systems
0072 Compressed Air System
0073 Control Buildings
0074 Lock Electrical System

These items shall have payment limited to no more than 93% prior to completion of the SEA TRIALS. Upon completion and acceptance of the SEA TRIALS, payment will be advanced to 100%. This is separate from any other retainage the Government may hold under this contract.

A SEA TRIAL Plan shall be submitted by the Contractor for approval by the Government. The Plan shall, minimally, include: a listing of each system identified above; performance requirements, times, controls and testing sequences; staff requirements (personnel furnished by the Contractor) for testing, recording, repairing and operating the systems; methods of recording and reporting; and coordination requirements with the Government's Lock Operations staff. A pre-submittal meeting will be

conducted to discuss the requirements of the Plan. Approval to proceed with SEA TRIALS will be given only after the Plan is approved and the coordination requirements arranged by the Government.

For the purposes of the SEA TRIALS, System Failure is defined as: "Any condition that causes the locking process to be halted due to a component malfunction, programming error, or unsafe condition".

The SEA TRIALS shall consist of the following 2 periods of sustained operation without system failure as prescribed further. The first period shall be 10 consecutive days of simulated lockage operation (no vessel in chamber) consisting of 4 daytime lockage operations and 4 nighttime lockage operations per day. Once this period is successfully completed, the second period shall be 10 consecutive days of actual lockage operations (vessel in chamber) consisting of 4 daytime lockage operations and 4 nighttime lockage operations per day. The total number of lockage cycles and the numbers occurring during the daytime and the nighttime shall remain fixed. Filling of the lock chamber shall be coordinated with the Lock Master in order to minimize surge conditions in the Louisville & Portland Canal, and will be limited as stated in Section 00800, paragraph 1.31.q.

The 4 daytime lockages each day will be within a single eight hour shift and the 4 nighttime lockages each night will be within a single 8 hour shift. The exact times of the shifts will be coordinated with the Government.

Each simulated or actual lockage operation shall be performed in accordance with Section 16900, paragraph 1.2. During the actual lockage period, a Lock Operator will be provided by the McAlpine Lock Master. The Contracting Officer may allow Lock Operator training to occur during this period, but training must be in accordance with Section 16900, paragraph 3.5, and Section 16920, paragraph 3.3.3. The training does not satisfy the additional training requirements as specified in Section 16910, paragraphs 3.2.1, 3.2.2, 3.2.3, and Section 16920, paragraphs 3.3.1 and 3.3.2. Full lockage operation shall occur during which the Contractor shall perform all of the operational requirements with the Government observing unless the Government allows proceeding without continuous observation. The Contractor shall provide towboat and barge equipment for the required lockages with a vessel in the chamber. The configuration shall be a towboat and 3 barges.

The Contractor shall promptly perform any repairs, equipment replacements, adjustments or corrections associated with a system failure during these SEA TRIALS. In the event a system failure should occur during either the simulated lockage operation period or the actual lockage operation period, the 10-day period in which the failure occurred shall start over once the Contractor has made repairs to the satisfaction of the Contracting Officer.

During and after the SEA TRIALS are completed, to the satisfaction of the Government, the Contractor will compile and submit a complete SEA TRIAL report for all systems. The report shall include all the entries identified in the Plan and the results obtained. Also, any adjustments/corrections/repairs required, operational notes, etc., shall be

included in the report.
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PART 2 PRODUCTS NOT

SECTION TABLE OF CONTENTS

DIVISION 02 - SITE WORK

SECTION 02130

CONTROL OF WATER

-- End of Section Table of Contents --

SECTION 02130

CONTROL OF WATER

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

This Section covers the work for removing and/or controlling all water required for keeping the cofferdam dry for the duration of the contract. The work also includes controlling any seepage through or beneath the coffercells, from the Kentucky bank, through or under the existing 1200' lock south wall, through the embankment between the 1200' lock south wall, and through or under the 360' nose pier, not intercepted by the water control systems; reducing the artesian head that may exist in the foundation bedrock that underlies the cofferdam; and lowering the water level in the coffercells, the upstream sheetpile binwall, and the 360 lock nose pier. The work required herein consists of furnishing all plant, labor, material, and equipment and performing all operations required for operating, maintaining, and supplementing (if necessary) the water control systems previously installed consisting of:

a. Wells, pumps, and discharge pipes for lowering the water level in the coffercells, upstream sheetpile binwall, and 360 lock nose pier.
b. Ditching, seeding, sandbagging and sump pumping to control surface water within the cofferdam so that the permanent work can be accomplished in the dry and free of the inwash of mud.

A water control system has been previously installed. The purpose of the existing system is to lower the water levels in the cofferdam cells, binwalls, 360 nose pier, and to relieve uplift acting on these structures. The Contractor shall be responsible for designing and installing additional measures necessary to maintain a dry cofferdam. This will include the control of rainfall and runoff into the cofferdam, seepage under and through cells, binwalls, nose pier, lock walls and soil slopes. The Contractor shall review and inspect the installed system and evaluate all available data. The Contractor shall be responsible for operation and maintenance of the existing systems and for operations and maintenance of whatever supplemental water control measures are necessary. Maintenance of the system will require maintaining all components of the system operating at the design performance levels. If any supplements or replacements are ever required they must be installed as specified herein and as directed or approved by the Contracting Officer. Some sections of this specification are only applicable to new installations.

1.1.1 Cofferdam

The cofferdam consists of two arms of steel sheet piling cells, the existing 1200' lock south wall, embankment between 1200' lock south wall and 360' nose pier, a portion of the 360' lock nose pier, an upstream and downstream binwall, and the Kentucky bank as shown on the drawings. Cell

9.5, a portion of Cell 10, Cell 12, and a portion of Arc 15.5 are concrete filled, as is the area between Cell 9 and the 360' lock nose pier. The in-situ material remains in the lower portion of Cell 16. The remaining cells and bin walls are filled with granular material, and a berm has been constructed inside the cofferdam to augment the stability of the cofferdam. The water control system will improve the stability of the cofferdam, reduce tension stresses in the interlocks of the cells and arcs, and relieve any uplift that may occur in the foundation bedrock underlying the cells.

1.1.2 Water Control in Coffercells

Wells have been installed in the circular cells and arcs. Wells shall be pumped to lower the water level in the cells to elevation 410 upstream, and 385 downstream, or the water level shall be within 5 ft of the bottom of the sand fill in cell 16, arc 15.5, and the upstream binwall. The elevation of the water level in these structures shall be determined from as-built well records.

1.1.3 Water Control in Upstream Binwall

Wells have been installed in the upstream binwall of the cofferdam to lower the water level in the wall fill to El 410 or the water shall be within 5 ft. of the bottom of the sand fill in the bin wall, whichever is higher.

1.1.4 Water Control in 360 Nose Pier

Wells have been installed in the center of the 360 lock north nose pier to lower the water level and collect any seepage through the masonry pier. Wells shall be pumped to lower the water level in the masonry pier to less than El 402.

1.1.5 Monitoring and Testing Water Control Systems

Piezometers have been installed to monitor the water level and hydrostatic head around the cofferdam, along the Kentucky bank, in the coffercells, in the upstream and downstream binwalls, and in the 360 nose pier. Supplemental or replacement instrumentation shall be installed in accordance with sections 13500 INSTRUMENTATION PROGRAM and 13503 PIEZOMETERS of the specifications. Supplements to the water control wells are to be tested for performance as they are installed.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

STATE OF KENTUCKY

KAR	Kentucky Administrative Regulations

1.3 REQUIRED WATER CONTROL FACILITIES

The systems that have been installed are the required water control facilities consisting of wells in the coffercells, binwalls, and nose pier, pumps and discharge pipes, piezometers, electrical and standby equipment, and flow measuring equipment. The Contractor shall accept this system and operate and maintain it as necessary to perform as required. It is not intended nor is it warranted that the minimum required facilities previously installed will remove or control all water as required by this specification. It is the Contractor's responsibility to control all water as specified herein even though the number, size, type, and components of the water control facilities may be more than those previously installed. If any additional facilities are required for the control of water, or if any monitoring systems are required in addition to those already installed, the Contractor shall include such additional features at no additional cost to the Government and without any extension of contract time. The Contractor shall also be responsible for design and construction of any supplemental dikes and drainage ditches needed to prevent any water from entering the protected area from the slope along the Kentucky bank and to collect and remove any seepage under or through existing structures. The Contractor is also responsible for winter protection of the discharge lines.

The existing water control system for control of water in the cofferdam cells, arcs, 360' lock nose pier and binwall consist of water wells with pumps controlled by a Variable Frequency Drive (VFD) system. The following is a VFD - Pump Controller Supply Organization Chart of the equipment in place:

Installer - Jensen Drilling Company
Supplier - United Pipe & Supply
Pump Manufacturer - Grundfos
Controller Manufacturer - Fuji
Drive Manufacturer - AC Technology
Assembly - Electro Pak

1.4 DEFINITIONS

1.4.1 Foundation Bedrock

The foundation bedrock underlying the cofferdammed area referenced in these specifications consists of four separate and distinct rock formations. These formations, in descending order of contact, consist of New Albany Shale, Beechwood Limestone, Silver Creek Limestone, and Jeffersonville Limestone. Due to multiple generations of previous construction, not all of these formations are present everywhere on the site.

1.4.2 Replacement Systems

Replacement systems are defined as the in-kind replacement of existing wells in the cells, arcs, binwall and 360' nose pier required to control the water levels and relieve uplift in these structures.

1.4.3 Supplemental Systems

Supplemental systems are defined as the installation of additional wells and/or pumps and associated features required to control seepage under or through the structures and slopes which comprise the cofferdam, through the foundation bedrock, or entering the excavation as rainfall or runoff.

1.4.4 Pressure Reduction

Pressure reduction is defined as a means of reducing the artesian head or hydrostatic uplift pressure on the cofferdam foundation.

1.4.5 Water Control

Water control as referred to in this section is defined as the control of the water levels in the cofferdam cells, arcs, and 360 nose pier, and the control of all water entering the cofferdam through or under the structures comprising the cofferdam, from runoff, from direct rainfall, or from any other source which introduces water into the cofferdam with the exception of controlled rewatering.

1.4.6 Unwatering

Unwatering is the process of removing all water from within the cofferdam after emergency flooding. Unwatering is covered in specification Section 02170 COFFERDAM.

1.4.7 Cofferdam

The cofferdam consists of the entire area bounded by the upstream and downstream coffercells and binwalls, the North wall of the old 1200' lock, and the south Kentucky bank, in which area the new lock is to be constructed.

1.4.8 Emergency Flooding

Emergency flooding is defined as the controlled process of filling the cofferdam with water from the Ohio River at a rate specified by the Contracting Officer. Emergency flooding is covered in specification Section 02170 COFFERDAM.

1.5 PAYMENT

1.5.1 Operation and Maintenance

Payment for operating and maintaining the water control system as outlined in this section will be included in the contract unit price per day for "Operation and Maintenance of Completed Work, (Including Power, Maintenance, Monitoring, and Repair for all Water Control, Instrumentation, and Other Completed Work)"as specified in the Bid Schedule. This daily rate shall constitute full compensation for furnishing all labor, equipment and supplies for operating and maintaining the water control system. This includes but is not limited to; furnishing system performance data, rehabilitation of pumps, redevelopment of wells, grouting abandoned wells, or other work as necessary to maintain the specified dewatered condition. Payments based on the daily contract unit price will begin at the beginning of the contract period. Payments at the contract unit price will continue to be made for the total balance of the contract period as extended by the

Contracting Officer for excusable delays until the the lock is complete and the cofferdam rewatered, or as directed by the Contracting Officer. The Contractor shall fully perform but shall not be compensated for any periods of delay determined by the Contracting Officer to be inexcusable. In the event it becomes necessary to flood the cofferdam, a revised unit price per day shall be negotiated with the Contracting Officer for the period between initiation of emergency flooding through the completion of the unwatering process.

1.6 SUBMITTALS

Government approval is required for submittals with a ``GA'' designation, submittals having an ``FIO'' designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMMITTAL PROCEDURES:

SD-01 Data

Water Control Plan; GA,ED.

The Contractor shall prepare, and submit for review, a detailed plan for installation, testing, operation, and maintenance of the water control and electrical systems. This plan shall be based on the Contractor's own assessment of site and subsurface conditions, and the installation and operation records from system that has been installed. The records for the installed systems shall be obtained from the cofferdam dewatering contractor as specified herein. The plan shall include the following, in addition to any requirements specified elsewhere.

The plan shall contain:
1) Locations of all water control wells.
2) Depth of all water control wells.
3) Method(s) for installing the coffercell, binwall, and 360 nose pier wells.
4) Number, type and specifications for drilling equipment.
5) Type, size, slotting, area of slots, and method of coupling screen and riser pipe to be used for the water control wells.
6) Source, gradation, and samples of filter material to be used for the various water control wells and piezometers.
7) Piping and valving to be used at the top of the cofferdam for measuring both flow and (any) sanding of the individual wells.
8) Methods for protecting the water control wells, header pipe, and electrical wiring and controls.
9) Plan and design of electrical systems for the water control wells, including wiring controls, switches, and automatic transfer switching to standby power generators, and for testing.
10) A coordination/short circuit study for the proposed electrical system.
11) Brand, type, size, and characteristics of submersible pumps to be installed in the water control wells.
12) Name, model, and description of water level sensor and pump speed or flow controller.
13) Type, number, and capacity of standby diesel generators (including automatic starting and switching equipment).

14) Proposed schedule and sequence for installation of the various water control systems.
15) Name and qualifications of the dewatering superintendent.
16) Method of measuring well flow data.
17) Layout of piezometers for checking performance of the water control system.
18) Method for reading piezometers and recording the data.
19) Typical detail of tip and riser pipe for piezometers.
20) Gradation of filter sand to be placed around piezometer tips.
21) Calibration records, make, and characteristics of flow meters for measuring discharge from water control wells.
22) Dikes and ditches to prevent surface water from flowing into the cofferdammed area.
23) Location and size of sumps.
24) Characteristics of sump pumps and horsepower of engines or motors.
25) Location, type, and size of discharge piping. (No surface water shall be pumped into the discharge for the cofferdam cell, arc, binwall, and 360 nose pier water control wells.)
26) Protection of slopes and stability berms from erosion.
27) Method, and type, number, and capacity of pumps for unwatering the cofferdammed area.

SD-18 Records

Test Records; FIO.

A copy of all inspection and test data relating to operation, maintenance, and performance of the water control systems, and any required supplemental water control facilities, shall be furnished to the Contracting Officer within 24 hours after the inspection or test is completed. During the initial testing and evaluation pumping, copies of test data shall be furnished to the Contracting Officer at the end of each day. The Contractor shall provide the Government with all significant operational, maintenance, and performance data and records. Any changes to the water control system shall be furnished to the Contracting Officer within five days for incorporation into the records.

Well Records; FIO.

When supplemental or replacment systems are installed, the Contractor shall record the following information regarding the installation of each well on a suitable form.

1) Water Control System (coffercell, binwall, or 360 nose pier)
2) Well number
3) Drilling method
4) Date of installation
5) Well screen (brand, material, diameter, schedule, and slot size)
6) Drilling superintendent
7) Ground or surface elevation at well
8) Depth to top of foundation bedrock
9) Groundwater table elevation
10) Riser pipe length
11) Screen length

12) Total depth of hole for well
13) Inside depth of well (from top of well riser)
14) Depth to sand in well after cleaning
15) Top of well screen [Ohio River Datum (ORD)]
16) Top of filter after placing (ORD)
17) Top of filter after development of well (ORD)
18) Top of seal after placing (ORD)
19) Top of seal after development of well (ORD)
20) Bottom of well (ORD)
21) Top of well (ORD)
22) Method of surging
23) Material surged into well (last cycle) in feet
24) Total material surged into well in feet

Pumping Test Records; FIO.

The Contractor shall submit for the individual pumping test on any supplemental or replacement well the following information:

1) Water Control system (coffercell, binwall, or 360 nose pier)
2) Well number
3) Location
4) Top of riser (ORD)
5) Date and time test started and stopped
6) Depth of water in well before and just before stopping pump
7) Elevation of water in well immediately before and just before stopping pump
8) Flow in g.p.m.
9) Rate of sand infiltration at the end of test in ppm
10) Depth of sand in well before and after pumping is completed
11) Depth of sand in well after cleaning
12) River stage
13) Rate of pumping and drawdown
14) Total pumping time
15) Rate of sand infiltration at the end of pumping in ppm

Water Control System Data Reports; FIO.

Water control system data shall be recorded as specified in paragraph 3.13.1. The data Water control system data shall be reported along with the instrumentation data as specified in section 13500 INSTRUMENTATION PROGRAM.

1.7 CONTRACTOR RESPONSIBILITY

The Contractor shall be responsible for:

1) Operating and maintaining the performance of the water control systems for the coffercells, upstream binwall and 360 nose pier. The systems shall be kept in their original condition,until all work in the cofferdam is complete and the cofferdam is rewatered. This will require 24-hour monitoring and should be accounted for in the subcontractor's bid. The Contractor shall be responsible for the installation, operation, and maintenance of any supplemental or

replacement systems installed under the direction of the Government.
2) Design, installation, maintenance, and operation of all necessary sump pumps and appurtenances for water control. Maintenance and operation of pumps for the water control wells; electrical distribution system; stand by equipment and spare parts; and appropriate controls and safeguards; all in accordance with the Contractor's approved Groundwater Control Plan.
3) Any additions and supplements that may be required to lower the water levels as specified or control any seepage from excavated slopes or into the bottom of the excavation to permit accomplishing the work in the dry. Supplemental measures may include the installation of wellpoints, inverted filters, French drains, and/or installation of additional wells, and appropriate pumps, piping, and appurtenances as necessary. Any additions and supplements installed shall become part of the existing water control system and shall be operated and maintained by the Contractor.
4) Monitoring the performance of the water control facilities.
5) Repairing all damage to work and to excavated areas caused by failure to maintain and operate the water control systems as specified.
6) Maintaining the electrical system, switching, and standby equipment for powering the pumps in the water control wells and for the sump pumps (if not powered with diesel engines).
7) Designing any features control systems not specifically covered by these specifications or drawings and including such in the Contractor's Water Control Plan.
8) Prior to the installation of any supplemental or replacement systems, the Contractor shall demonstrate that higher than specified piezometric levels are not the result of poor performance of the water control system due to operation and/or maintenance.
9) A meeting shall be arranged between the existing contractor and the new contractor to allow for proper turnover of equipment. This meeting shall consist of a demonstration and walk-through of all the equipment to acknowledge the condition it is in for turnover and to discuss any problems or procedures as identified by the existing contractor relating to the system. Minutes of the meeting shall be taken by the lock contractor and include any pretakeover survey problems that may need to be taken care of under warranty of the existing contractor. It should also consist of a list of all equipment and components to be received by the new Contractor. Any concerns about the transition of the existing equipment should be brought up at this time. The cofferdam contractor and the lock contractor shall coordinate the turnover so that the system is continuously operated and maintained.

Any noncompliance with the above specified groundwater control requirements or with the Contractor's approved Water Control Plan shall be promptly rectified in accordance with these specifications.

1.8 QUALIFICATIONS AND DUTIES OF CONTRACTOR

1.8.1 General

The Contractor shall engage the services of an experienced dewatering Subcontractor to perform maintenance and installation of the water control system. The subcontractor shall have at least five years of responsible experience in the design, installation, and operation of dewatering systems for deep locks and dams built in major alluvial valleys. The dewatering subcontractor shall have appropriate equipment for installing piezometers and dewatering wells by the reverse-rotary, or bucket auger methods, as appropriate for conditions at this site. Equipment suitable for penetration of sound and continuous bedrock will be required. The Subcontractor shall also be experienced in the design and installation of electrical systems and controls for the pumps to be installed in the wells.

1.8.2 Dewatering Superintendent

***3**

The Contractor shall designate and have on site a Dewatering Superintendent with at least three years of responsible experience in the installation of water wells and dewatering system. The Qualifications of the Dewatering S uperintendent shall be submitted with the Water Control Plan in accordance with Paragraph 1.6 SUBMITTALS. The Dewatering Superintendent shall be responsible for ensuring that the water control and electrical systems are installed in compliance with the Contractor's approved Water Control Plan with respect to materials, testing, operation, and maintenance of the systems and that the water levels in the cells, arcs, 360' nose pier and binwall are controlled as specified herein. The Dewatering Superintendent's duties shall also include, but not be limited to, those described below. **The responsibilities of the Dewatering Superintendent as specified herein shall take priority over any other on sight activity that the Dewatering Superintendent engages in.**

***3**

1.8.2.1 Materials and Equipment

The Contractor's Dewatering Superintendent shall supervise all tests and/or measurements to determine that all materials incorporated in the work are in accordance with the drawings and specifications and with the Contractor's approved Water Control Plan. Materials and equipment to be checked shall include, but not be limited to, drilling equipment, well screens, riser pipes, filter sand, pumps, diesel generators, automatic starting and power transfer equipment, well discharge pipe and fittings, header pipe, valves, discharge outlets, piezometers, water level controllers in the wells, flow measuring equipment, and related materials and equipment.

1.8.2.2 Installation

The Contractor's Dewatering Superintendent shall personally verify that specified and/or approved procedures and methods for installing any wells, pumps, piezometers, headers, electrical systems, and any replacement or supplemental water control facilities are followed.

1.8.2.3 Operation and Maintenance

The Contractor's Dewatering Superintendent shall supervise the operation and maintenance of all installed water control systems, electrical systems, replacement and supplemental water control facilities. The Dewatering Superintendent shall also regulate the rate of pumping the water control wells so that a constant water level is maintained in the wells. He shall obtain all required river stage, piezometric, well performance, and flow data for and during the specified pumping and evaluation tests, and as required during construction monitoring. The Contractor's Dewatering Superintendent shall also inspect the test-starting of each nonoperating pump and diesel generator weekly (including the backup diesel generator) and include, in a daily report, reference to the conduct of the test, the number of pumps and diesel generators tested, any unsatisfactory performance data, and any remedial action taken. The Contractor's Dewatering Superintendent shall immediately notify the Contractor, and the Contractor shall immediately notify the Contracting Officer, concerning any event or information not in accordance with either these specifications or the approved Water Control Plan.

1.8.2.4 Quality Assurance

The Contracting Officer shall have access to and the right to inspect any equipment and supplies provided in connection with installing the water control system, and to inspect installation, operation, maintenance, and performance of such systems.

***1**

1.9 INSTALLED SYSTEM

All information in this section is based on preconstruction data. More current data are available from installation and operating records for the installed system **including the specific sizes, locations, and quantities of installed equipment, spare parts, and electrical distribution equipment** at the McAlpine Resident Engineers Office, 2750 Marine Street, Louisville, KY 40212.

***1**

1.9.1 Subsurface Data

Subsurface boring logs are shown on the drawings. The design memorandum and remaining samples of materials taken from subsurface investigations may be examined by appointment by contacting the Geotechnical and Dam Safety Section of the Louisville District (Phone 502-315-6445). Prospective bidders are encouraged to examine all available data. Because of the nature and volume of this material, the data must be examined at the Louisville District Office. These data represent the best subsurface information available: however, variations may exist in the subsurface between boring locations. Portions of the McAlpine project date to the 1850's and the site conditions have been impacted by multiple generations of construction. The reports, plates, and data made available for inspection are solely for general information purposes. Most of the borings were made with a hollow stem auger and split-spoon sampler. Generally, the alluvial sand could be penetrated to foundation bedrock with the augers used. Many boring logs shown on the drawings are based on samples taken with 1-3/8-in. I.D. split-spoon samplers capable of only recovering gravel or stones smaller than about 1 in. The fact that the boring logs do not show the existence of gravel or cobbles does not necessarily mean that these materials are absent at or between the borings. Wherever any difference occurs between the referenced reports and these specifications, the requirements of these specifications control.

1.9.2 Subsurface Conditions.

The cofferdam floor is comprised of foundation bedrock consisting of New Albany Shale, Silver Creek Limestone, Beechwood Limestone, and Jeffersonville Limestone. A contour map of the surface of the foundation bedrock in the area of the locks is shown in the drawings. This map was developed prior to cofferdam unwatering and these contours should be considered approximate.

1.9.3 Chemical Characteristics of River Water

The chemical characteristics of the river water, based on samples of water taken from the river near McAlpine, are given in the following tabulation.

CHEMICAL CHARACTERISTICS OF GROUNDWATER

River Mile	602.0
Date Sampled	1998 Average
pH	7.9
Temperature	63.2 F
Total Hardness (CaCO3)	150.7
Total Calcium	40.1 mg/l
Total Magnesium	12.0 mg/l
Total Sodium	20.6 mg/l
Chloride	33.3 mg/l
Sulfate	61.0 mg/l
Total Iron	1.6 mg/l
Total Manganese	0.1 mg/l

1.9.4 Pumping Test

A pumping test has not been performed at this site. It shall be the responsibility of the Contractor to make his own evaluation of the relation of the boring records and laboratory data to the general subsurface conditions at the site.

PART 2 PRODUCTS

2.1 General

The product requirements as set forth herein represent minimum product specificatons. The products for replacement of existing systems shall be in-kind.

2.2 WELL TOPS AND PROTECTION OF WELLS

The tops of wells shall be temporarily sealed immediately after completion of installation with a PVC cap that shall be kept in place at all time, except during cleaning and pumping operations. Each well shall be protected with three 4-in. standard weight steel pipes 5 ft long set 30 in. deep in an 2-ft. diameter concrete filled hole. These guard posts shall be sandblasted, primed, and painted Day-glow orange for ready visibility, and the number of the well painted thereon in 2-in. high block numerals. Any damage to a well during or after installation shall be repaired within 72 hours.

2.3 SUBMERSIBLE PUMPS AND WIRING.

***1**

It shall be the responsibility of the Contractor to provide new submersible pumps **for any additional spare pumps or any pumps installed** under this contract. The pumps installed shall have new fittings, as described below:

***1**

a. A water level controller for each pump in each of the wells to maintain the water level in the well constant (1 ft.) and to prevent surging and air from entering the pump bowl to minimize incrustation. The water levels within the wells may be controlled by varying pump speed using a variable speed controller. The controller shall be set to control the water level in the wells at the following elevations:

Well	Design Water Level in Well (Elevation)	Pump Intake (Elevation)
Upstream Cell	410	397
Upstream Arc	410	397
Upstream Binwall	410	397
360 Nose Pier	402	397
Downstream Cell	385	367
Downstream Arc	385	367

b. Pumps for wells shall be fitted with a PVC or approved metal shroud attached to the pump bowl and extending to the bottom of the electric motor. The shroud must be connected so that all flow will pass by the motor.

c. Each submersible pump shall be provided with a check valve.

d. All electrical wiring and controls for the pumps shall be new and waterproof.

2.3.1 Submersible Pump Capacities

The submersible pumps in the existing system have the following minimum capacities for the different water control wells. Replacements shall be in kind. Minimum pump capacities may be modified based on development tests and as approved by the Contracting Officer.

Upstream coffercell wells, Q_w = 20 gpm and TDH = 65 ft
Upstream arc wells, Q_w = 30 gpm and TDH = 65 ft
Upstream binwall wells, Q_w = 20 gpm and TDH = 65 ft
360 Nose pier wells, Q_w = 20 gpm and TDH = 65 ft
Downstream coffercell wells, Q_w = 75 gpm and TDH = 85 ft
Downstream arc wells, Q_w = 105 gpm and TDH = 85 ft

2.4 DISCHARGE SYSTEM.

Water from the water control wells may be pumped into the Ohio River, as shown schematically on the drawings. The minimum discharge system shall have an additional 50% capacity over that required for the initially installed system. The discharge system shall be provided with valves that permit disconnecting the pump for each well individually without interfering with pumping from any other wells. The discharge piping shall be new, and shall be steel with a wall thickness of at least 0.188 inches. All discharge pipe and fittings shall be of a size so that the total friction losses in the discharge and header pipes for any pump do not exceed 15 ft to 20 ft for the design flow rates for the wells. The discharge system shall be constructed with threaded couplings on the discharge line to make future removal operations easier. All discharge and/or header pipes shall be protected from damage that could be caused by construction equipment or operations.

2.5 MATERIALS OTHER THAN PUMPS AND DISCHARGE SYSTEM.

2.5.1 Riser Pipes.

The riser pipe for the wells shall be 8-in. in diameter and shall be Sch. 40 PVC minimum.

2.5.2 Screen.

The screens for the wells shall be new and shall be slotted with 0.015-in slots with at least 5 percent of open area. The screen section of the water control wells shall extend down to within 2 ft to 3 ft of the bottom of the well. The approximate length of screens for the dewatering wells shall be as follows:

Upstream Cell Wells - 25 ft (see Para 3.7)
Upstream Arc Wells - 25 ft (see Para 3.7)
Upstream Binwall Wells - 25 ft (see Para 3.7)
360 Nose Pier Wells - 25 ft (see Para 3.7)
Downstream Cell Wells - 58 ft (see Para 3.7)
Downstream Arc Wells - 58 ft (see Para 3.7)

2.5.3 Filter Sand.

Filter sand around the well screens shall be a washed, clean, uniformly graded sand composed of hard, tough, and durable particles free from any adherent coating. The filter sand shall contain no detrimental quantities of organic matter, nor soft, friable, thin, or elongated particles; it shall be uniformly graded; and shall fall within the following gradation requirements:

FILTER SAND GRADATION
FOR
WATER CONTROL WELLS

U.S. Standard Sieve No.	Percent by Weight Passing
1/4	90 - 100
4	75 - 100
8	30 - 72
10	22 - 60
16	8 - 27
20	0 - 15
30	0 - 7
40	0 - 2
50	-
70	-

The coefficient of uniformity of the filter sand shall range from 2.5 to 6.

2.6 SPARE PARTS.

***1**

The Contractor will be provided the minimum inventory of spare parts for the installed system as listed below. The Contractor shall maintain the following minimum inventory of spare parts in first class condition at the site at all times. The minimum inventory shall also include spare parts for any supplemental systems installed.

***1**

Discharge Piping and Fittings: 5% of all pipe and fittings within the system;
Submersible Pumps: At least 5% of complete pump, motor, and necessary electrical switch gear (disconnect switches), magnetic starters, and miscellaneous electric fittings;
Standby diesel generators: One (1). The generator shall be equipped for replacement within 2 hours of main generator failure.
Flow meters for measuring flow from water control wells, if installed for this purpose: Five (5)
Miscellaneous: Ample supply of fuses, electrical wire, electrical fittings, PVC fittings, and other miscellaneous components of the system.

PART 3 EXECUTION

3.1 GENERAL.

The water control systems for the coffercells, binwalls, and 360 nose pier shall be installed, operated, and maintained by the Contractor to lower the piezometric level in the coffercells and provide pressure relief to the foundation bedrock, as specified herein. Surface water and seepage from any slopes, under or through existing structures, through the cofferdam foundation, or into the bottom of the excavation, shall also be controlled so that construction inside the cofferdam can be accomplished in areas free of water.

3.2 CONTROL REQUIREMENTS.

Control of water to be performed by the Contractor shall consist of:

* Lowering the piezometric levels as follows:
* Coffercells - Lower the water level in the cells and arcs to El 410 upstream, and 385 downstream, or within 5 ft of the bottom of the sand fill in coffercells.
* Binwall - Lower the water level in the upstream binwall to less than El 410, or within 5 ft of the bottom of the sand fill in the binwall.
* 360 Nose Pier - Lower the water level in the 360 nose pier to less than El 402.
* Testing electrical systems and standby generators, including automatic startup and transfer of power, for proper performance.
* Testing the water control systems for mechanical and electrical performance after flooding before beginning to unwater the cofferdammed area.
* Preventing erosion of excavated slopes along the Kentucky bank from any seepage by means of filter blankets, toe drains, or other measures for controlling seepage.
* Preventing erosion of stability berm slopes and excavated slopes as a result of surface runoff by constructing intercepting dikes, seeding, stone slope protection, and/or other approved means.
* Providing adequate sump pumping equipment to promptly remove rainfall falling or flowing into the cofferdammed area.
* Preventing surface water at the top of the south Kentucky bank from flowing into the excavation, by diking, sump pumping, or other approved means.
* Providing supplemental measures necessary to control the seepage of water from the soil slopes, through and under existing cofferdam structures and from the foundation bedrock.

* Monitoring construction piezometers and replacing or supplementing as necessary to prove the adequacy of the water control systems.
* Operating and maintaining the water control systems shall be continued until the lock construction is complete and the cofferdam is rewatered.

The Contractor shall operate, maintain, and supplement as necessary dikes, ditches, sumps, pumps, and discharge piping for controlling surface water that falls or accumulates from any source to prevent flooding of the work area or excavation. The systems or features for controlling surface water shall be designed with sufficient storage and pumping capacity to prevent any significant flooding of the excavations for the following rainfall periods, assuming 100 percent runoff:

Rainfall

Period	Amount (inches)
30 minutes	1.25
1 hour	2.0
2 hours	2.50

In any event, the Contractor shall be responsible for controlling whatever surface runoff occurs, regardless of rainfall intensity and duration, and protecting the work area. The methods and equipment to be used shall be detailed in the Contractor's Water Control Plan. Proper procedures for handling this water must be submitted for approval prior to discharging water from the excavation and shall be in accordance with KPDES storm water permit #KYR000001 and the Water Quality Certification issued by the Kentucky Department for Environmental Protection, Division of Water, certification #2000-0118-1. As required by the Water Quality Certification, all water pumped from construction areas must be treated to remove settleable solids prior to discharge to the Ohio River. The Water Control Plan shall describe the method that will be used to remove settleable solids from the water prior to discharge. Settled solids shall not be pumped into the Ohio River.

Under no circumstances shall the Contractor discharge water from the cofferdam to a surface water (Ohio River) if a sheen is present on the water, or if the discharge may create a sheen on surface water after discharged. The Contractor shall describe measures that it will implement for the disposal of cofferdam water in the event that sheening is an issue, i.e. treatment to remove sheen prior to discharge or arrangements for alternate disposal of the water.

3.3 TESTING WATER CONTROL SYSTEMS

In the event the cofferdam is flooded, all components of the water control system shall be made fully operational prior to unwatering. After proving the mechanical and electrical performance of the water control systems, all of the systems shall be put into operation and monitored in accordance with Para 3.11, MONITORING WATER CONTROL SYSTEMS. Once unwatering of the cofferdammed area is started, the water level in the coffercells shall be kept lowered in accordance with the requirements set forth in Para 3.2, CONTROL REQUIREMENTS.

3.4 LOCATION OF WATER CONTROL WELLS

The water control system has been installed at approximately the locations shown in the drawings. Any supplemental wells considered necessary by the Contractor shall be located as shown on the Contractor's approved Water Control Plan.

3.5 DRILLING

3.5.1 General

Drilling for the water control wells shall be performed by a certified driller in accordance with the Kentucky Department of Environmental Protection, Division of Water regulations. Certification shall be in accordance with 401 KAR 6:310 through 401 KAR 6:320. Refer to Section 01410, Environment Protection, paragraph 3.6.2 for additional requirements pertaining to submittal of water well record forms to the Kentucky Department for Environmental Protection, Division of Water. Drilling the holes for the water control wells shall be carried out to prevent any appreciable displacement of the materials adjacent to the hole or any reduction in the yield of the well. With the exception of the holes in the 360 Nose Pier, the holes for the water control wells will be started in cell fill material, setting a temporary surface casing before the start of drilling to prevent the top of the hole from caving will probably be necessary while drilling for the well. The Contractor shall accurately log the surface of the foundation bedrock while drilling the holes for the water control wells, and the logs promptly made available to the Contracting Officer. This information is necessary for determining and setting the screen for the wells to be installed in the water control wells. If obstructions are encountered which the Contractor considers impractical to advance the drill hole to the design depth for the well, the Contractor may abandon the well and construct another well at an adjacent location approved by the Contracting Officer, at no additional cost to the Government and with no extension in contract time. Abandoned wells shall be backfilled with granular material conforming to the gradation of cell fill in Specification Section 02170 COFFERDAM. The water control wells shall be installed using one or a combination of the following methods and no others. Soils including cell fill shall be drilled using the reverse rotary method, and approved bucket auger and procedure. Bedrock shall be drilled using rotary, percussive, cable-tool, or coring procedure. The drilling equipment used must be capable of penetrating the bedrock formations at the site. Regardless of the method used for installing the wells, the method of developing and test pumping the wells shall be the same. Water used for jetting or as makeup water for the reverse-rotary or bucket auger method of drilling shall be relatively clear water such as can be obtained from the Ohio River or by pumping from other wells previously installed. Because of the different types of materials to be penetrated by the water control wells, different types of equipment and drilling methods may be required for installing the water control wells. The drilling methods used shall be capable of advancing holes through the cell fill material as specified in Section 02170 COFFERDAM, and through the cell foundations.

3.5.2 Reverse Rotary Method.

The reverse rotary method for installing the wells shall consist of drilling the hole with a bit attached to (typically) a 6- or 8-in. drill stem and sucking the cuttings from the bit out of the hole by means of a high-capacity dredge pump, an airlift pump, or a jet-eductor pump. For the reverse rotary method of drilling, water from the pump is recirculated through a sump from which the drilling water flows back into the drilled hole. Material removed from the hole settles out in the sump. For this method of drilling, the water level in the hole shall be maintained at least 7 ft above the existing river level at all times until the well screen, riser pipe, filter, and backfill have been placed. The hole drilled for the well shall be at least 20 in. in diameter to permit the use of a bit with 5-in. openings to minimize difficulties cell fill that may be encountered. While drilling and installing the well, the drill hole shall be kept full of natural drilling fluid with turbidity (suspended solids) of about 3,000 ppm up to the ground surface. No bentonitic drilling mud shall be used while drilling or installing the well. Silt may be added to the drilling water to obtain the desired degree of turbidity, if necessary. If naturally turbid water, or water with silt added, proves insufficient to keep the hole stable, an approved organic drilling compound, such as Johnson's Revert or equal, may be added to the drilling fluid. Regardless of the type of fluid used, the Contractor shall use a sump pit large enough to allow the sand to settle out but small enough so that some silt is kept in suspension. If Revert drilling fluid is used in drilling the hole for a well, all drilling fluid in the hole shall be replaced with clean, fresh Revert with a Marsh funnel viscosity of 32 to 45 seconds, before setting the well screen and placing the filter. All drilling fluid shall be removed from the well filter and the subsurface formations by development after the well is installed.

3.5.3 Bucket-Auger Method.

Any holes drilled by the bucket-auger method shall be drilled with water with turbidity less than 3000 ppm. The bucket-auger shall be fitted with sharp curved blades or equal that will trim the sides of the hole as the hole is advanced as approved by the Contracting Officer. The top of the hole shall be cased (a minimum of 5 ft to 10 ft) to prevent caving at the top of the hole. For this method of drilling, the water level in the hole shall be maintained at least 7 ft above the water level at the well until the well screen, riser, filter, and backfill have been placed. If clay or silt exists above the portion of the well to be screened, the drilling fluid, if muddy, shall be replaced with clear water or thinned with clear water to turbidity less than 1000 to 2000 ppm, prior to drilling into the zone where the well will be screened. If a drilling fluid additive is required, only approved organic polymers, such as Johnson's Revert or equal, shall be used. Before installing the well screen, the drilling fluid in the hole shall be replaced with clean drilling fluid or thinned with clear water by an approved method to a turbidity of less than 1000 to 2000 ppm. No bentonitic drilling fluid shall be used.

3.6 DEPTH OF WELLS, SCREENS, AND FILTER.

3.6.1 Wells in Coffercells, Arcs, and Binwall.

The wells for lowering the water level in the coffercells, arcs, and upstream binwall shall extend from the top of the cells down 5 feet into the limestone bedrock, approximately El 385 upstream, and approximately El 362 downstream. These wells shall consist of riser pipe from the top of the cofferdam down to El 420 +/- 3 ft with screen down to the bottom of the well. The filter for the wells shall extend from 2 ft or 3 ft below the bottom of the screen to 6 ft to 8 ft above the top of the screen. Above this elevation, the space between the well riser and hole or casing shall be filled with either filter sand or any locally available clean fine sand.

3.6.2 Wells in 360 Nose Pier.

The wells for lowering the water level in the 360 Nose Pier shall extend from the top of the pier down 5 feet into the limestone bedrock, approximately El 385. These wells shall consist of riser pipe from the top of the pier down to El 420 +/- 3 ft with screen down to the bottom of the well. The filter for the nose pier wells shall extend from 2 ft or 3 ft below the bottom of the screen to 6 ft to 8 ft above the top of the screen. Above this elevation, the space between the well riser and hole or casing shall be filled with either filter sand or any locally available clean fine sand.

3.7 ASSEMBLY AND INSTALLATION OF WELLS

3.7.1 Assembly of Screen and Riser Pipe.

The joints between the screen and riser pipe shall be solvent welded. The screen and riser shall be centered in the well hole or casing and held securely in place during placement of the filter by means of centering devices. Prior to the installation of any screen and riser, the Contractor shall submit to the Contracting Officer for approval, full details of the method, equipment, and devices he proposes to use for centering and holding the screen and riser pipe in the well hole or casing. One centering device shall be provided at the bottom of the screen, with a minimum of one additional centering device for each 20 ft of screen or riser.

3.7.2 Installation

The assembled screen and riser pipe shall be placed in the well hole to avoid jarring impacts and to ensure that the assembly is not damaged or misaligned during installation.

3.7.3 Alignment

Each completed well shall be sufficiently straight and plumb that a cylinder 10 ft long and 2 in. smaller in diameter than the inside diameter of the well can be lowered the full depth of the well and withdrawn without binding against the sides of the screen or riser pipe. A variation of 6 in. per 50-ft depth of well will be permitted in the alignment of the combined screen and riser pipe from a plumb line at the top of the well; however, this will not relieve the Contractor of his responsibility for maintaining adequate clearance for surging and pumping the well.

3.7.4 Placement of Sand Filter

After the screen and riser pipe for the cell, arc, binwall, and 360 nose pier wells have been installed, the specified filter sand shall be pumped or tremied around the well screen up to at least 6 ft above the top of the screens. Above this elevation, the space around the riser pipe may be filled with filter material or locally available sand.

3.7.5 Development of Wells.

Within 4 hrs after installation, the water control wells shall be pumped for not less than 30 minutes. If Revert was added to the drilling fluid, Johnson's Fast Break or equal shall be added to the well in accordance with the manufacturer's recommendations to break down the Revert prior to surging. Development of the well shall be started within 12 hrs after the well has been pumped. Development shall consist of surging the well, while simultaneously pumping with a submersible pump or by air lifting, with a surge block raised and lowered through the well screen at a speed of about 2 ft per sec. The gaskets on the surge block shall be slightly flexible and have a diameter between 0.50 and 0.75 in. smaller than the inside diameter of the well screen. The amount of material deposited in the bottom of the well shall be determined after each cycle. Each cycle shall consist of 15 trips. Surging and air lifting shall continue for a minimum of 30 minutes or until the amount of material deposited in the bottom of the well in one cycle becomes less than 0.2 ft. The well screen shall be pumped clean if the accumulation of material in the bottom of the well becomes more than 1 foot anytime during surging. The well shall also be cleaned of any material in the well after surging and air lifting are completed. Material pumped from the well shall be visually inspected to see if any cell fill material is being removed. After surging is completed, the well shall be pumped until the discharge is clear and contains less than 5 ppm sand. Such pumping shall begin within 1 hour after surging and shall continue for not less than 1 hour. The well shall be pumped at a constant rate equal to the design capacity of the pump for that system; if that flow rate causes a drawdown more than 10 ft, the pumping rate shall be reduced so as not to produce a drawdown more than 10 ft. The suction pipe or hose from the pump shall extend to the bottom of the well. If a submersible pump is used to test the well, the bottom of the pump shall be set about one (1) ft above the bottom of the well. If, when pumping is completed, the well is producing sand at a rate greater than 5 ppm, the well shall be resurged and pumped again. Alternate surging and pumping shall be continued until material entering the well during either surging or pumping is less than the amount specified above, but not for more than 6 hrs. Wells that continue to produce an excessive amount of sand or filter material after 6 hrs of pumping shall be abandoned if directed by the Contracting Officer except that, if he so elects, the Contractor may continue to develop the well by an approved method. If, after such further development, a well meets the above stated requirements, it shall be completed, and after successful completion of the required pumping tests, it will be accepted as satisfactory. After completion of all surging and pumping, any material in the bottom of the well shall be removed by pumping from a suction hose or pipe that extends to the bottom of the well. Water pumped from wells during well development shall not be discharged to surface water, i.e. Ohio River, due to anticipated high turbidity levels. Water pumped from wells during development shall be discharged to the ground surface. The Contractor shall record pertinent data regarding the installation of the well.

3.7.6 Disinfection of Drill Hole and Filter Sand.

During the drilling operation, 2 lbs. of 70-percent calcium hypochlorite shall be added to the drilling fluid at the beginning of drilling and every 4 hrs thereafter if the reverse-rotary or bucket auger method is used. If Revert is used, calcium hypochlorite shall be added when displacement of the fresh drill fluid is completed. As the filter sand is placed in the well, 70-percent calcium hypochlorite shall be added to evenly distribute a minimum of 2 lbs. per ton of filter placed. Upon completion of a well, a minimum of 5 lbs. of granular 70-percent calcium hypochlorite shall be dropped in the well, and mixed by surging the full length of the screen for

10 trips.

3.8 PUMPING TEST ON EACH WELL.

Upon completion of installation, surging, development pumping, and before final acceptance, each well shall be subjected to a pumping test. Before the start of a pumping test, and again after completion, the depth of the well shall be accurately measured by the Contractor in the presence of a Government representative. The well shall be pumped with a submersible pump set about one (1) foot above the bottom of the well. The pump shall have a capacity equal to or greater than the minimum specific capacity. The Contractor shall provide an approved means for accurately measuring both the flow from the well and the water level in the well. The Contractor shall provide and install the necessary discharge pipe and throttle valve so that the flow from the well can be pumped at a constant rate and discharged into the Ohio River as approved by the Contracting Officer. The pumping and sand infiltration tests shall be conducted by the Contractor in the presence of a Government representative. The Contractor shall record and furnish pumping test records in accordance with Section 1.6 SUBMITTALS. The Contractor shall test each well by pumping continuously for a minimum of 1 hour. Pumping shall be at a constant rate equal to the design capacity of the pumps for that water control system but not greater than the rate that will cause a drawdown in the well of more than 10 ft. No test pumping of a well shall be conducted concurrently with surging or pumping of any other well within 100 ft. If sand or other materials infiltrate the well during the pumping test, the following procedures shall be followed:

3.8.1 Resurging Test Pump.

If the rate of infiltration of sand during the last 30 minutes of the pumping test is more than 5 ppm, the well shall be resurged by manipulation of the test pump for 15 minutes. The test pumping shall then be resumed and continued at the rate specified above until the sand infiltration is reduced to less than 5 ppm. If, after such additional test pumping and other remedial measures, the sand infiltration in the well is reduced to less than 5 ppm, the well will be accepted.

3.8.2 Abandoning Well.

If after 4 hrs of pumping, the infiltration of sand is more than 5 ppm, the well shall be abandoned unless the Contractor elects to continue to test pump and perform other approved remedial work approved by the Contracting Officer. All wells and piezometers shall be grouted to the top of the screen prior to demolition of the cofferdam.

3.8.3 Sand Removal Upon Test Completion.

Upon completion of the pumping test, any sand or filter material in the bottom of the well shall be removed by pumping or other approved procedure.

3.9 PUMPING AND WATER LEVEL CONTROL

The wells shall be pumped continuously at the maximum rate commensurate with the rate of inflow to the wells so that the pumping rate does not exceed the (limiting) rate of flow into the wells for the design pump setting. This shall be accomplished by:

Installing a water level controller that will control an electronic actuator capable of operating a valve in the pump discharge line so as to maintain a specified or approved water level within the water control well within +/- 1 foot. Alternately, a pump speed controller may be installed which varies pump motor speed to maintain a +/- 1 ft water level. Water level controllers or pump speed controllers shall not be influenced by temperature, mechanical wear, or moisture [see Para 2.3].
Installing a clear section of plastic pipe in the discharge pipe between the top of the well and the header pipe or (open) discharge point for observing whether or not the pump is pumping water with any air entrainment;
Installing a throttling valve in the discharge line at the top of the well for valving the flow to minimize variation in the flow of water through the valve controller; and
Providing a sounding tube in the well to determine the water level in the well. The bottom of the tube shall be set at or below the bottom of the pump.

3.10 WATER CONTROL ELECTRICAL SYSTEM

Three-phase power is available at the site. It is the Contractor's responsibility to arrange for electrical service and to be sure that the demand can be met. It will also be the Contractor's responsibility to make the necessary arrangements for and to pay for the electrical services furnished. One hundred (100) percent connected diesel engine generator standby capacity, with connected automatic start-up and transfer switching from commercial power to generator power has been provided. The standby generator(s) and electrical controls and switching are of such design and capacity that all of the submersible pumps in the wells in the cofferdam can be brought on line within 10 minutes after loss of commercial power. If replacement generators are required, the generators shall be new and each shall be provided with the accessories recommended by the manufacturer for starting the diesel engine(s) such as trickle chargers, water and oil heating elements, etc. The generators and electrical controls shall be housed in suitable weatherproof sheds or buildings. The generators shall be provided with fuel tanks with sufficient fuel for 50 hours of engine operation. The generators and associated switchings shall be turned over to the government upon completion of the contract. The electrical controls for the submersible pumps shall include automatic restarting of the pumps in the event of any temporary outage. The electrical system for powering the submersible pumps shall also be of such design that any one pump can be safely disconnected and removed without interfering with the operation of any of the other pumps. A weatherproof control and switch box for each pump shall be mounted at El 447 on a 6- by 6-in. treated wood post set in concrete 3 ft deep near each well. This post shall be painted Day-Glow orange and the number of the well stenciled thereon in large black letters. A red running light shall be installed on either the control box or the post, wired to illuminate when that pump is not operating. All electrical wiring shall be encased in pipe or electrical conduit buried in a marked trench and surrounded with concrete colored orange at least 3 in. thick, or securely strapped to the discharge pipes so that the wires are protected against damage. All electrical wiring shall comply with the temporary wiring requirements of the latest edition of the National Electrical Code published by the National Fire Protection Association. Each control panel shall have supplemental grounding by installing a direct buried bare copper #1/0 AWG wire from the control panel's ground terminal to the top of the cell's sheet metal piling. Connection at the metal piling shall be by fusion welding process. A minimum size #1/0 AWG ground wire shall be ran from the main electrical service equipment to each control panel. Contractor shall prepare and submit a coordination/short circuit study for the proposed electrical system for review by the government.

3.11 MONITORING WATER CONTROL SYSTEMS

Continuous control of water levels and uplift pressure in the work area is essential for the safety of the cofferdam and for proper construction operations and schedule. It is therefore imperative that the water control system prevent and control seepage in the work area at all times from any source, including the Ohio River adjacent to the excavation. The Contractor shall make measurements and submit them to the Contracting Officer as specified herein. The Government reserves the right to install supplemental water level and flow measuring devices and to observe and/or make measurements of contractor-installed monitoring piezometers; however, such installations and observations shall not relieve the Contractor of his responsibility to install the specified minimum devices, and to obtain the minimum observations and analyses of the data to insure his compliance with the specified performance.

3.11.1 Water Levels.

The Contractor shall read and record the water level in all piezometers and in the water control wells as set forth below for information and use in operating the dewatering systems specified. The Contractor shall also record which wells are being pumped when piezometer and water level readings are taken. The Contractor shall furnish copies of all piezometer and water level readings to the Contracting Officer within 24 hrs of being taken. All data shall be reported as specified in Section 13500, "Instrumentation." The readings and measurements should be made in accordance with the following schedule.

Measure the water levels in the piezometers, and wells daily.
Measure the flow from individual wells and the total flow from the dewatering system, Mon., Wed, and Fri.
Measure any sand in the flow from all of the water control wells, Wed.
Read the river stages upstream and downstream of the work area, daily.
Check each well whether or not the pump is pumping air, daily.

3.11.2 Well Flow.

Flow from individual wells may be measured with an approved flow meter installed in the discharge line from the pump (that reads directly in gpm), or by shutting off flow to discharge or to the discharge header as the case may be, and then opening the diversionary valve and measuring the flow volumetrically with a calibrated container and a stop watch. Any sanding of the well can be similarly checked in this manner. The Contractor under the direction of the Contracting Officer shall make all flow measurements.

3.11.3 Sanding.

The flow from each well shall be checked for sanding. The rate of sanding shall be determined by taking a measured amount of water being pumped from each well and then determining the sand content. The maximum acceptable rate of sanding shall be 5 ppm.

3.12 OPERATION AND MAINTENANCE

3.12.1 Supervision

Operation and maintenance of the well systems, any necessary supplemental water control facilities shall be supervised by the Dewatering Superintendent as specified in Section 1.8, QUALIFICATIONS AND DUTIES OF CONTRACTOR. Supervisory personnel shall be present on site during normal working hours and shall be available on call 24 hrs a day, 7 days a week, including all holidays.

3.12.2 Operating Personnel

***3**

Sufficient personnel (a minimum of three during **regular** day shift and one on all other shifts) skilled in the operation, maintenance, replacement, and monitoring of water control systems, pumps, equipment, and electrical systems and generators, shall be onsite 24 hrs a day, 7 days a week, including holidays, when the systems are in operation. The system shall be monitored continuously to ensure proper operation. In the event that maintenence is required these personnel shall discontinue all other activities immediately in order to perform the necessary repairs to restore the system to full operating condition.

***3**

3.12.3 Repair and Replacement

The pumps and controls shall be maintained in operable condition at all times with no more than two wells or pumps inoperative at any one time. The Contractor shall immediately repair or replace any well or pump that becomes inoperative. Should the efficiency of a well or pump show any significant reduction relative to its initial efficiency, the Contractor, shall clean the pump and redevelop and/or chemically treat the well to restore its efficiency. If the efficiency of the well cannot be restored, a replacement shall be installed. In case of failure of any component of the water control systems, including piezometers, such component shall be repaired or replaced and completed within 8 hrs. The electrical power system to the water conrol pumps shall be designed, maintained, and operated to be failsafe. The necessary small tools, hoisting equipment, and other equipment required for repairs shall be in good condition and shall be kept at the site full-time while the water control systems are in operation. Replacement equipment and materials shall conform to the requirements of these specifications. The Contractor shall be solely responsible for the cost of all repairs and maintenance of specified and any supplemental wells, piezometers, pumps, diesel generators, and the electrical system. In the event that the cofferdam is flooded, the Contractor shall repair all components of the water control system at no additional cost to the Government. The Contractor shall start all pumps before unwatering begins. Monitor all wells and piezometers during unwatering to evaluate their performance and ability to meet the design requirements. Any problems with the water control system shall be immediately corrected by methods such as rehabilitating the wells or increasing pump capacity. The system shall lower the piezometric levels to those shown in paragraph 3.2.

3.12.4 Maintenance

The Contractor shall have a regularly scheduled maintenance program that conforms with the equipment manufacturer's recommendations and includes all other work necessary to maintain all system components fully operational. The maintenance program shall include, checking the flow rate and water elevation in each well, as specified in paragraph MONITORING WATER CONTROL SYSTEMS starting each diesel generator and nonoperating pumps weekly and operating the generators and nonoperating pumps for a minimum of 30 minutes. All pumps, both operating and nonoperating, shall be independently tested monthly for wear. The Contractor shall clean or replace all pumps that do not lower the water level in the well to the elevations given in paragraph SUBMERSIBLE PUMPS AND WIRING. The chemical content of the water may cause a certain amount of clogging of filters, well screens, pump bowls, risers, and discharge pipes, by chemical incrustation and iron bacteria. If such clogging should occur, the Contractor shall take the necessary measures to clean and/or redevelop or replace the wells or equipment if necessary. Any cleaning and/or redevelopment of water control wells shall be subject to approval of the Contracting Officer, but such approval shall not relieve the Contractor of his responsibility to cofferdam achieve the water control levels specified. The Contractor shall include in his maintenance program the cleaning of all pumps and screens as necessary to ensure the system is operating in accordance with the design. This will require the removal of the pump and visual inspection of the well along with cleaning of pumps, screens, and associated piping as needed. The Contractor shall utilize a commercially available software package to maintain his daily maintenance log and provide a copy to the Resident Engineer as requested. The Contractor shall provide maintenance to the water control system until the cofferdam is rewatered.

3.13 GROUNDWATER PROTECTION PLAN

The Contractor is referred to Section 01410 ENVIRONMENT PROTECTION, paragraph 3.6.1, for discussion regarding preparation and implementation of a groundwater protection plan for water well construction, installation, and abandonment activities.

-- End of Section --

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DIVISION 02 - SITE WORK

SECTION 02221

COFFERDAM DEMOLITION

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SECTION 02221

COFFERDAM DEMOLITION

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

The work covered by this section consists of performing all operations in connection with demolition of the cofferdam including but not limited to: sheet pile cells, upstream and downstream binwalls, sheet piling and concrete around the upper 360' lock nose pier, floodgates and bridge, cell fill and berm removal, and temporary anchor detensioning. Materials that cannot be removed daily shall be stored in areas specified by the Contracting Officer. All demolition work shall be performed in accordance with EM 385-1-1, Section 23, Demolition, and other applicable sections. Salvage of constructon materials shall be pursued to the maximum extent possible; salvaged items and materials shall be disposed of as specified.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ENGINEERING MANUALS (3 Sep 1996)

EM 385-1-1	(1996) U.S. Army Corps of Engineers Safety and Health Requirements Manual, Eng Form 5044-R

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-08 Statements

Work Plan; GA,RE.

The procedure proposed for the accomplishment of the work. The procedures shall provide for safe conduct of the work, including procedures and methods to provide necessary supports, lateral bracing and shoring when required, careful removal and disposition of materials specified to be salvaged, protection of property which is to remain undisturbed, coordination with other work in progress, and timely disconnection of utility services. The procedures shall include a detailed description of the methods and equipment to be used for each operation, and the sequence of work progression in accordance with EM 385-1-1.

Cofferdam Removal and Storage; GA,RE.

Prior to demolition of the existing structures, submit for approval a removal and storage plan. The plan shall include, but not be limited to:

a. Method of removing stone protection,
b. Method for removal of sheet piling, cell fill, dewatering pumps, and well casings,
c. Method of removing piezometers and inclinometers,
d. Sequence for removal of cofferdam cells,
e. Method of stacking such that each sheet pile stack will contain the same length sheets,
f. How the stacks will be bundled,
g. Method to transport sheets to storage area.
h. Method to protect bundles.
i. Removal of all cut-offs or scraps damaged during sheet pile removal.
j. Method of inventory to keep track of each sheet.
k. Method of cleaning sheets.
l. Method of removal for remaining items.

1200' Lock Anchor Detensiong Plan; GA,ED.

The procedure proposed for the accomplishment of the work. The plan shall identify the contractor's qualifications in high capacity post-tensioined rock anchors and the detensioining thereof. Qualifications of the personnel to perform the work shall also be submitted. The plan shall describe the contractors equipment and methods to detension the anchors and restore the lock wall in accordance with these specifications.

1.4 MEASUREMENT AND PAYMENT

1.4.1 Removal of Existing Cofferdam

Payment for removal of the existing cofferdam cells and all other related items as described herein shall be made under the lump sum bid item "Removal of Existing Cofferdam" as listed in the Bidding Schedule. This includes removal of sheet pile cells, upstream and downstream binwalls, sheet piling and concrete around the upper 360'lock nose pier and the 360' lock nose pier above final grade, floodgates and bridge, cell fill and berm removal, resulting rubbish and debris, and all work incident thereto. Storage of reusable cofferdam sheet piling will be paid as described below in 1.4.2 "Storage of Reusable Cofferdam Sheet Piling". The government estimated quantity of sheet piling to be pulled is 154,610 linear feet of PS 27.5 piling and 13,464 linear feet of PZ22 piling. As an option to the contract, the Contractor will be required to accept all sheet piling for salvage. In this option, payment (or credit) will be made under the bid item "Reusable Cofferdam Sheet Piling". No payment will be made under "Storeage of Reusable Cofferdam Sheet Piling" if this option is invoked. A contract option for "Salvageable Generators" shall also be bid for the Contractor to accept the dewatering generators as salvage. A schedule for payment shall be prepared by the Contractor to be incorporated into the NAS for payment purposes of all demolition work.

1.4.2 Storage of Reusable Cofferdam Sheet Piling

Payment for storage of reusable cofferdam sheet piling will be made at the applicable contract price per linear foot under the bid item "Storage of Reusable Cofferdam Sheet Piling" for stored piling. Payment under this item shall only include piling that has been designated by the Government as being reusable. Payment shall cover all costs of handling and storing piling including stacking, inventorying, transporting, separating, and sorting of reusable sheets. Disposal of scrap and nonuseable piling shall be included for payment under paragraph 1.4.1 Removal of Existing Cofferdam. A schedule for payment shall be prepared by the Contractor to be incorporated into the NAS for payment purposes of storage of reusable cofferdam sheet piling.

1.4.3 Contractor Damage of Government Salvage Item

Prior to removal of any salvaged material, a Government Representative and the Contractor will establish the physical condition of the salvaged items. Photographs will be taken and agreements made on the condition of all salvaged items. If the salvaged items are damaged beyond repair during removal, transportation, or storage as a result of the Contractors operation or negligence, the Government will be due a credit as outlined in the table below. This credit will be deducted from the lump sum amount for bid item "Removal of Existing Cofferdam" under the changes clause of the contract.

ITEM	UNIT	CREDIT PRICE
Sheet piles	LF	$10.00
Generators	EA	$35,000.00

1.5 PROTECTION

1.5.1 Protection of Personnel

During the demolition work the Contractor shall continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site. No area, section, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

1.5.2 Protection of Existing Property

Before beginning any demolition work, the Contractor shall survey the site and examine the drawings and specifications to determine the extent of the work. The Contractor shall take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the Government; any damaged items shall be repaired or replaced as approved by the Contracting Officer. The Contractor shall coordinate the work of this section with all other work and shall construct and maintain shoring, bracing, and supports as required. The Contractor shall ensure that structural elements are not overloaded and shall be responsible for increasing structural supports or adding new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

1.5.3 Environmental Protection

The work shall comply with the requirements of Section 01410 ENVIRONMENT PROTECTION. Dewatering wells, piezometers, and inlcinometers shall be decommissioned in accordance with all local, state, and federal requirements.

1.6 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

1.7 USE OF EXPLOSIVES

The use of explosives for demolition will only be permitted for demolition of concrete in cofferdam cells 9.5, 10,12, and around the 360' lock nose pier and the 360' nose pier. Specimens taken from cores from cells 9.5 and 12 exhibited the following compressive strengths:

Cell 9.5, 10' - 12' depth 4200 psi/4700 psi
Cell 9.5, 45' - 47'depth 4700 psi/5000 psi
Cell 12 10' - 12' depth 3770 psi/4170 psi
Cell 12 45' - 47' depth 4820 psi/4780 psi

***3**

No other demolition work will be allowed to use explosives. The use of explosives shall be in accordance with Section 02226 of the specifications. **No measures were made during construction of the cofferdam to prevent bonding between sheet piling and concrete.**

***3**

1.8 AVAILABILITY OF WORK AREAS

Areas in which the work is to be accomplished will be available upon issuance of Notice To Proceed issued by the Contracting Officer, unless otherwise noted on the contract drawings.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 EXISTING STRUCTURES

3.1.1 General

All demolition, removal, and storage actvities shall be performed in accordance with the contractor's approved submittal. Concrete removal adjacent to permanent structures shall be performed such that no resulting damage occurs to the permanent structures.

Existing structures to be removed include complete removal of cofferdam cells 1 through 15 including connecting arcs, upstream and downstream binwalls, and stone protection around the cells. All emergency spiral stair towers and ramps are to be removed. The cofferdam flood gates, spillway and bridge are also to be removed. Cell 16 and the 360' lock nose pier and the concrete and sheet piling surrounding it shall be removed to 2 feet below final grade. Arc 15.5 shall be removed to the top of the concrete fill, elevation 397. The Contractor will remove the berm and grade the site as shown on Sheets C-22 and C-23. Earth berm removal adjacent to sheet pile cells shall not take place until the cofferdam has been rewatered. Some of the cell or berm fill will be reused as fill as shown on sheet C-28. The remainder of cell fill and berm fill shall be disposed of offsite. No cell fill or berm fill is to be disposed of in the river.

3.1.2 Cell Fill and Berm Removal

The removal of cell fill and the berm shall consist of excavation and disposal of the previously placed cell fill and berm. Excavation of the cell fill and berm material shall be by clamshell, hydraulic backhoe, dragline, or similar method. Absolutely no hydraulic dredging of this material will be allowed.

Before removing the fill from a cell, the connecting arc cell fill shall be removed from the arcs immediately adjacent to the cell. If excavation must be made deeper to ease pulling of sheets, the arc cell fill shall be removed such that the differential fill height in the arcs immediately adjacent to the cell does not exceed 50 feet. After the fill in the adjacent arcs has been removed, the fill in the cell can be removed.

Removal of the berm shall not proceed until the cofferdam is completely rewatered. The berm shall be removed and the area graded as indicated on the drawings.

3.1.3 Sheet Pile Removal

The removal of sheet pilings shall consist of pulling, sorting, cleaning , inventorying, and storing previously installed sheet pilings as described herein, as shown on the drawings and as directed by the Contracting Officer. The Contractor will be provided a copy of the as-built cofferdam drawings showing locations and details of all cofferdam features. The Contractor shall be responsible for the removal of all dewatering well casings and pumps for disposal or salvage.

3.1.3.1 Pulling

The method of pulling piling shall be in accordance with the contractor's approved removal and storage plan, along with the pulling of pump casings, removal of sand fill in cells to be removed, and method of sorting, cleaning, inventorying, and storing the old sheets. When pulling piling, the Contractor should make every effort to recover the piling in a usable condition. Pulling holes shall be provided in pilings as required. Extractors shall be of suitable type and size. Care shall be exercised during pulling of pilings to avoid damaging piling interlocks and adjacent construction. If the Contracting Officer determines the adjacent permanent construction has been damaged during pulling the Contractor will be required to repair this construction at no cost to the Government. Pilings shall be pulled one sheet at a time. Pilings fused together shall be separated prior to pulling unless the Contractor demonstrates to the satisfaction of the Contracting Officer that the pilings cannot be separated. Piling damaged beyond structural use will be paid for under " REMOVAL OF EXISTING COFFERDAM".

3.1.3.2 Sorting, Cleaning, Inventorying and Storing

All piling at least 10 feet in length after cutting as specified herein shall be salvaged unless it has been damaged beyond structural use. Each pulled piling will be individually inspected by the Government and a determination made on whether or not it will be reused. Reusable piling will be that piling determined by the Government to meet the manufacturer's tolerances for new piling. It is the Government's estimate that 75%-90% of the cofferdam sheet piling will be salvageable and 10%-25% will need to be scrapped. The piling shall then be sorted, cleaned by pressure washing, inventoried and stored by type into groups as:

a. Reusable piling - This piling shall be organized into stacks of four and stored on the site at the location shown on the drawings and as approved by the Contracting Officer.

b. Non reusable piling - This piling shall become the property of the Contractor and shall be removed from the site and not paid for under "Storage of Reusable Cofferdam Sheet Piling."

The reusable piling shall be cleaned in the interlocks and on both sides of the web with a stream of water under a pressure of no less than 3000 psi. The cleaning shall remove any encrustation which prevent free sliding in the interlocks. The webs shall be cleaned of encrustation. Measures shall be taken to prevent water and debris from the cleaning operation from contaminating the already cleaned sheets.The Contractor should anticipate a considerable amount of zebra-mussel encrustation will occur on the sheet piling and will require removal during cleaning of the sheets.

Usable piling shall be stored on Shippingport Island as directed by the Contracting Officer. Prior to storing sheet piling, the storage area shall be prepared by removing all surface vegetation and topsoil. The storage area shall be graded and a foundation layer consisting of 12 inches of KYDOH Crushed Stone Base material shall be placed in the area where sheet pile storage and storage activities are to occur. Positive drainage shall be maintained in the storage areas at all times. Usable piling shall be transported to the storage area where it will be stacked. Piling shall be stacked in groups of four separated by 4" by 4" wooden blocks. The wooden blocks shall be of sufficient length to "tie" adjacent stacks for stability, and shall be placed such that a continuous "tie" is achieved ***3** through the entire stack. Piling is not to be stacked higher than ***3** 10 feet, and wye piles are to be kept in a stack separate from the straight-web sheets.

3.1.4 Detensioning of Temporary Anchors

The vertical and inclined strand anchors in Monolith M1 through Monolith M15 of the existing 1200' lock south wall shall be detensioned. All detensioning activities shall be conducted in accordance with the Contractor's approved plan. The Contractor shall engage the services of a specialty subcontractor to perform all aspects of the anchor detensioning. The specialty subcontractor shall be experienced in all aspects of the installation and removal of high capacity multi-strand post-tensioned anchors. The subcontractor's personnel who are to perform the work shall be experienced in the detensioning of anchors. The inclined anchors in Monolith M4 and M13 shall be detensioned prior to rewatering of the cofferdam, but shall not be detensioned when the upper pool level is anticipated to exceed elevation 425 prior to rewatering. The vertical anchors in Monoliths M1 through M15 shall be detensioned following rewatering. The strands shall be detensioned individually by the application of heat or other approved method such that the load from the remaining tensioned strands remains evenly distributed on the anchorage. The process shall continue until all of the strands have been detensioned. Following detensioning, all anchorage recesses shall be filled with miscellaneous concrete with an expansive admixture flush to the top of the lock wall.

3.2 DISPOSITION OF MATERIAL

Title to materials and equipment to be demolished, excepting Government salvage is vested in the Contractor upon receipt of notice to proceed. The Govenment will not be responsible for the condition, loss or damage to such property after notice to proceed.

3.2.1 Salvageable Items and Materials

3.2.1.1 Material Salvaged for the Contractor

Material salvaged for the Contractor shall be stored as approved by the Contracting Officer and shall be removed from Government property before completion of the contract. Material salvaged for the Contractor shall not be sold on the site.

3.2.1.2 Items Salvaged for the Government

Salvaged items to remain the property of the Government shall be removed in a manner to prevent damage and packed or crated to protect the items from damage while in storage or during shipment. Items damaged during removal or storage shall be repaired or replaced to match existing items. The items reserved as property of the Government shall be delivered to the areas designated. Refer to Section 00800 Paragraph 1.23 for a list of salvaged items for the government. All usable sheet piling shall be hauled to the sheet pile storage area and stacked as previously indicated as directed by the Contracting Officer. All items not salvaged for the Government shall become the Contractor's responsibility and be removed from the site.

3.2.2 Unsalvageable Materials

Concrete, masonry, and other material, except concrete permitted to remain in place, shall be transported off Government property at the Contractors expense in accordance with the Contractor's approved Solid and Hazardous Waste Management Plan defined in Section 01410.

3.3 CLEANUP

Debris shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

-- End of Section --

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DIVISION 02 - SITE WORK

SECTION 02226

FOUNDATION BLASTING AND EXCAVATION

03/01

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SECTION 02226

FOUNDATION BLASTING AND EXCAVATION
03/01

PART 1 GENERAL

***1**
1.1 GENERAL REQUIREMENTS AND SCOPE

This section covers all operations in connection with rock excavation for the lock structure, gate bay structure, culvert excavation, and if necessary, removal of selected coffercells. **All drilling and sampling requirements must be met, as specified in SECTION 02210: Drilling and Sampling.** Additional excavation requirements are included in other sections, as appropriate. This section describes the various kinds of blasting and excavation required to accomplish the contract work and specifies the conditions under which the excavation is to be performed. Within the limitations of these specifications, plans, and in accordance with the construction sequence, the excavation may be carried out by any approved method and by any excavating and hauling equipment suitable for the work, as may be proposed by the Contractor and approved by the Contracting Officer or his authorized representative.

The Contractor shall conduct all blasting operations in conformance with KRS Sections 351.340, KAR Title 805 - Chapter 4, pursuant rules, laws, and regulations issued by the Department of Mines and Minerals, May, 1995, EM 385-1-1 Safety Manual, and specifications as specified herein. No blasting operations shall occur between the hours of 7 p.m. and 7 a.m. on any day of the week. In case of a conflict between the rules, regulations, and specifications, the more stringent shall apply as determined by the Contracting Officer. ***1**

1.2 REFERENCES

The publications listed below form a part of these specifications to the extent referenced. The publications are referred to in the text by the basic designation only.

U.S. Army Corps of Engineers Publication.

EM 385-1-1	Safety and Health Requirements Manual
EM 1110-2-3800	Systematic Drilling and Blasting for Surface Excavations

***1 Reference has been deleted *1**

State of Kentucky

KRS	Kentucky Revised Statutes
KAR	Kentucky Administrative Regulations

International Society of Explosives Engineers

Blaster's Handbook, 17th Edition

Blaster's Handbook, 17th Edition

1.3 RECORDS OF SUBSURFACE EXPLORATIONS

Records consisting of drive sampling, auger borings, and core boring data gathered to determine the characteristics of the materials at the site have been compiled by the Government. Subsurface geologic boring logs are shown on the drawings. Recent subsurface exploration samples that were not consumed during testing, field logs of borings, reports of investigations at the site, and other additional information, are available for examination by prospective bidders. Prospective bidders are encouraged to contact the Government to arrange for examination of all available data by contacting the Geotechnical and Dam Safety Section at (502) 315-6370. Because of its nature and quantity, this material must be examined at Government facilities in Louisville, Kentucky. These data represent the available subsurface information; however, variations may exist in the subsurface between boring locations. Portions of the McAlpine Project date to the 1830's and the site conditions have been impacted by multiple generations of construction. It should be noted by the bidder, that historical blasting has fractured the bedrock materials. It should be expected that these blast fractured cedrock charecteristics shall be incountered during blasting and excavation of the foundation materials.

1.4 SUBMITTALS

Submittal and Approval Procedures. The Contractor shall make all submittals to the Contracting Officer no less then thirty (30) days, and many cases sixty (60) days, before the proposed date for the start of the item of work involved, and shall not start the item of work until said submittal is approved. The Contracting Officer will review the Contractor's proposal and approve the proposal when it meets the requirements of these specifications. The final decision for any proposal having provisions differing from the requirements of these specifications will rest with the Contracting Officer. Upon approval the Contractor shall not deviate from the proposal without the prior written approval of the Contracting Officer. Review and approval of proposals by the Contracting Officer does not relieve the Contractor of the responsibility for the work or the way in which it is performed. The Contractor acknowledges by submittal of this plan:

(1) That the Contractor has prepared bids based on his assessment of the nature and extent of the work involved;

(2) That he has determined that the design included in the

Excavation Plan includes sufficient allowance for variations normally encountered in earthwork and excavation;

(3) That the cost of the equipment proposed includes spares, backups, supplementary equipment as needed to complete the work; and

(4) That modifications of the Excavation Plan, directed by the Contracting Officer or found to be necessary by the Contractor, shall not constitute the basis of a claim unless such claim is specifically allowed by another provision of these specifications.

The submittal of items required in paragraphs, "Foundation Excavation Plan" through "Plan for Excavation Adjacent to Structures" below shall each be made under separate cover so as to prevent the undue delay of one proposal while another undergoes review and re-submittal.

Government approval is required for the submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with SECTION 01335 SUBMITTAL PROCEDURES:

SD-08 Statements

Seismic Specialist; GA, ED.

The Contractor shall provide the Contracting Officer with seismic specialist's resume citing, in addition to other pertinent information, his past experience, training, and education. The Seismic Specialist shall have at least 5-years experience in similar blasting, including training in vibration control methods and the capability of analyzing results from blasting seismographs. The acceptability of the seismic specialist shall be subject to the approval of the Contracting Officer.

Blasting Specialist; GA, ED.

***3**

The Contractor shall submit the resume, experience, and training of the blasting specialist to the Contracting Officer. The submittal shall detail the experience and training which the Contractor believes qualifies the specialist for work under this contract. The Blasting Specialist shall **be a licensed blaster and** have at least 5-years experience in similar blasting. The acceptability of the blasting specialist shall be subject to the approval of the Contracting Officer.

Blaster-In-Charge; GA, ED.

The Contractor shall submit the resume, experience, and training of the Blaster-In-Charge to the Contracting Officer. The submittal shall detail the experience which the Contractor believes qualifies the specialist for work under this contract. The Blaster-In-Charge shall be a licensed blaster and have at least 5-years experience in similar blasting. The acceptability of the Blaster-In-Charge shall be subject to the approval of

the Contracting Officer.

***3**

SD-18 Records

Foundation Excavation Plan; GA, ED.

The Contractor has the flexibility under these specifications to employ a variety of excavating equipment. Accordingly, the Contractor shall prepare, for review by the Contracting Officer, an Excavation Plan that shall include but not be limited to: the type, location, and sequencing of excavating equipment; type, location, and sequencing of methods to be used; location of test sections to insure proper technique; the numbers of each type of equipment to be used; the approximate vertical and horizontal limits of excavation for each type of equipment and method; the number and types of hauling equipment to be used; the proposed traffic patterns and haul road locations; and the location of required and proposed stockpile areas. The locations of haul roads and the sequence of operations such as stripping, exploration drilling, blasting, and excavation shall all be shown in detail in the Contractor's proposed Excavation Plan. Details of the excavation, disposal area, spoil, and any other aspect of the excavation and disposal of material within the required excavation shall be included in the Contractor's Excavation Plan whether or not specific requests are made elsewhere in these specifications. This submittal shall require 60 days for review and subsequent approval.

Blasting Plan; GA, ED.

The Contractor shall submit proposed plan for drilling and blasting of rock, for approval. The Contractor shall utilize the provided Excavation Method Plans as guidance to complete the detailed Blasting Plan. The Contractor's plan shall show the location and depth of holes, inclination of wedge cut holes, amount and strength of explosives per hole and per round, sequence of firing and time delays, and estimated length of pull per blast. All blasting operations shall be subject to approval. The Contractor shall submit for the Contracting Officer's review a plan detailing all the pertinent aspects of the blast designs including the type of explosives, loading, firing, delay sequence, and special considerations. The plan shall also address, if necessary, all pertinent aspects in blasting and removal of the selected concrete coffercells. The Contractor shall address his ability to adjust the blasting plan to changing geological characterizations within the foundation, including lithological changes, natural joints and fractures, as well as histoically blast fractured bedrock. Government approval of the blasting plan shall not relieve the Contractor of any responsibility for the blasting operation. ***3** The blasting plan shall be completed and signed by **The Blasting Specialist**. This submittal shall require 60 days for review and ***3** subsequent approval.

Special Excavation Plan; GA, ED.

The Contractor shall submit a plan detailing the specialized procedures to be used for the excavation of the various gate sills, gate monoliths, culverts, etc. It shall address potential locations for test areas to determine the adequacy of the techniques. The special excavation plan ***3** shall be completed and signed by **The Blasting Specialist**. This ***3** submittal shall require 60 days for review and subsequent approval.

Buffer Zone Excavation Plan; GA, ED.

The Contractor shall submit a plan detailing the specialized procedures to be used for the buffer zone excavation of the various areas identified in the Excavation Plan Sheet and in the Contractor's submitted Foundation Excavation Plan. It shall address potential locations for test areas to determine the adequacy of the techniques. The buffer zone excavation plan ***3** shall be completed and signed by **The Blasting Specialist**. This***3** submittal shall require 60 days for review and subsequent approval.

Plan for Excavation Adjacent to Structures; GA, ED.

The Contractor shall submit a detailed plan showing the specialized methods and procedures to be used for this type of excavation which may qualify as "Excavation Adjacent to Structures" as adapted for each specific application where this type of excavation is required. It shall address potential locations for test areas to determine the adequacy of the techniques. The plan for excavation adjacent to structures shall be ***3** completed and signed by **The Blasting Specialist.** This submittal ***3** shall require 60 days for review and subsequent approval.

Blasting Work Plan; GA, RE.

The Contractor shall submit detailed procedures that will be used when blasting. This includes personnel that will be involved with the blasting operations at the site, storage, and transportation of explosives, techniques and types of equipment to be used for blasting, blasting components, safety precautions, etc. The plan shall state procedures that shall be used to allow the uninterrupted passage of river traffic, including red flag barges. The blasting work plan shall be completed and ***3** signed by **The Blasting Specialist**. This submittal shall require 60***3** days for review and subsequent approval.

Blast Vibration Monitoring Plan; GA, ED.

Submit detailed procedures for monitoring blast. Plan shall include type of equipment, locations and mounting of equipment for each blast, and qualifications of personnel. Reference is made to 805 KAR 4:030. The blast vibration monitoring plan shall be completed and signed by ***3 The** seismic specialist. This submittal shall require 30 days ***3** for review and subsequent approval.

Safety Plan; GA, RE.

The Contractor shall submit a safety plan as specified in COE EM 385-1-1. The safety plan shall consider the general public, as well as the contractor and site personnel, explosive storage, transportation, ***3** handling. The safety plan shall be completed and signed by **The Blasting Specialist.** This submittal shall require 30 days for review ***3** and subsequent approval.

***1**
Pre-Blast Survey; GA, RE.

Submit a record of pre-blast survey performed on major structures near the work area, and **as listed in paragraph 3.1.2 Pre-blast Survey.** The pre-blast survey shall be completed prior to the start of any blasting. ***1**

Blast Records; GA, RE.

Submit a record of each blast on the project. Information shall be the same as required by 805 KAR 4:050. Completed blast records, including printed seismic and airblast data, shall be submitted to the Contracting Officer within 1 hour after each blast.

Blast Notification; GA, RE.

Submit a record of all utility, property owners, etc, who have been contacted, and by what means they have been contacted, in regards to the use of explosives as the project.

1.5 PAYMENT

A survey of the site shall be made just after commencement of the work under this contract and prior to the initiation of any excavation. All measurements for payment for excavation will be based on that survey and additional surveys as specified hereinafter without regard to any changes that may occur during the prosecution of the work. Quantities for payment for excavation will be determined in cubic yards based on cross-section measurements. All quantity computations for excavation payment will be made using the average end area method from cross-sections taken at suitable intervals. All decisions concerning classification of the excavated materials will be made by the Contracting Officer. Payment for excavation will be made only for the volume of materials actually removed by the Contractor, and only for the material excavated within the limits shown on the drawings or established in the field by the Contracting Officer. Payment for any given volume of excavation will not be made under more than one classification of excavation. Payment for excavation will constitute full compensation for all costs associated with removal, hauling, stockpiling, and disposal of the excavated materials.

1.5.1 Common Excavation

Common excavation will be conducted and measured for payment as described in SECTION 02300, EARTHWORK.

1.5.2 Conventional Rock Excavation

Rock excavation will be measured for payment based on the volume of material between the top of rock established in the field by the Contracting Officer, and the grade lines as shown on the drawings or as modified in the field by the Contracting Officer, or to the surfaces where the classification changes, which ever is applicable. Where the character of the materials and the methods of removal do not qualify a given volume of rock excavation for payment under one of the special classes of rock excavation, measurement and payment will be made for "Conventional Rock Excavation". Payment will be made at the contract price per cubic yard for "Conventional Rock Excavation" which price shall constitute full compensation for all labor, materials, equipment, blasting, stockpiling, and miscellaneous items which are necessary to complete the work as specified.

1.5.2.1 Buffer Zone Excavation

Buffer zone excavation will be measured for payment based on the volume of rock excavated using the specified buffer zone techniques in areas designated for this type of excavation, including pre-splitting, stemming, etc. Payment will be made at the contract price per cubic yard for "Buffer Zone Excavation" which price shall constitute full compensation for all labor, materials, equipment, blasting, stockpiling, and miscellaneous items which are necessary to complete the work as specified.

1.5.2.2 Special Excavation

Special excavation will be measured for payment based on the volume of rock excavated using the specified special excavation techniques in areas designated for this type of excavation, including pre-splitting, mechanical excavation, etc. Payment will be made at the contract price per cubic yard for "Special Excavation" which price shall constitute full compensation for all labor, materials, equipment, blasting, stockpiling, and miscellaneous items which are necessary to complete the work as specified.

1.5.2.3 Excavation Adjacent to Structures

Excavation adjacent to structures will be measured for payment based on the volume of rock excavated using the specified techniques in areas designated for this type of excavation, including pre-splitting, mechanical excavation, etc. Payment will be made at the contract unit price per cubic yard for "Excavation Adjacent To Structures" which price shall constitute full compensation for all labor, materials, equipment, blasting, stockpiling, and miscellaneous items which are necessary to complete the work as specified.

#3
1.5.2.4 Line Drilling

Line drilling will be measured for payment based on the number of square yard of permanent rock face formed using line drilling techniques as specified **or as approved. Line Drilling will be measured and paid seperately, regardless as to the type of excavation method the line drilling is used in conjunction with.** Line drilling performed at the Contractor's option, in areas other than those designated in the specifications or as directed **or approved** by the Contracting Officer, will not be measured for payment. Payment for line drilling will be made at the contract price per square yard for "Line Drilling" which price shall constitute full compensation for all labor, materials, equipment, and miscellaneous items which are necessary to complete the work as specified.

#3

1.5.3 Pre-Blast Survey

Payment for pre-blast surveys will be made at the applicable contract lump sum price for "Pre-Blast Survey" as listed in the Bidding Schedule which price shall include the cost of all plant, materials, labor, and equipment for performing pre-blast surveys.

1.5.4 Refill

Refill will be measured for payment based on the number of cubic yards of concrete used as refill in a vertical wall made necessary by overexcavation which is not due to fault or negligence on the part of the Contractor, as paid for under contract unit prices in SECTION 03700: MASS CONCRETE.

1.6 LIMITS OF FOUNDATION EXCAVATION

The limits of the proposed foundations for the various parts of the work are approximately as indicated on the drawings. The Contracting Officer reserves the right to change the depth to, or the width of, the foundations if, in the opinion of the Contracting Officer, conditions exposed in the foundation excavations, or as determined by exploratory drilling, warrant such modifications. The limits of foundation excavation can only be changed by obtaining authorization from the Contracting Officer. Where such modifications are made, the Contractor shall not be entitled to any compensation beyond contract unit prices.

1.6.1 Rock Cleanup of Excavated Areas for Inspection

Inspection may be necessary at various stages of the excavation operations in order to determine the condition of the rock and the requirements for further excavation. The work required to perform this cleanup will be conducted, measured and paid in accordance with Section 02217: Foundation Preparation.

1.6.2 Exploratory Drilling

The Contractor, as directed by the Contracting Officer, shall perform such exploratory drilling as may be required to determine the condition of the rock before, during, or after excavation operations in a given area. All exploratory drilling shall be performed in accordance with SECTION 02210: Subsurface Drilling, Sampling, and Testing. When conducting exploratory drilling before foundation excavation, the drilling shall be conducted at least 300 feet ahead of the foundation blasting and excavation.

1.6.3 Drilled Shafts for Floating Mooring Bits

Drilled shafts to be used for the mooring bits, located within the footprint of the RCC monoliths, shall be drilled to full depth before the conventional excavation or buffer zone excavation in the lock chamber. These drilled shafts shall be such size to accommodate the floating mooring bit dimensions, as shown in the plans, with no hindrance in movement during operation. The diameter of the shafts shall be 46-inches in diameter, have the shaft center located at the same location as the center of the mooring bit recess within the monolith, and have a minimum functional bottom elevation of 367. The shafts shall meet tolerance criteria set in SECTION 02466, DRILLED SHAFTS. After the lock chamber excavations in front of these shafts have reached the required founding elevation, a rock wedge between the front of the blast face back to the shafts shall be removed by mechanical means. This slot shall be removed from the top of rock down to the bottom of the chamber excavation, approximately elevation 367 (as depicted on sheet F-22). The drilled shafts shall be cleaned and prepared to remove all loose rock from the sides of the shafts and all loose debris from the bottom of the shafts. Drilling for these shall be conducted and payment measured as determined in SECTION 02466: DRILLED SHAFTS. Cleaning of these shafts shall be conducted and payment measured in accordance with SECTION 02217, Paragraphs 1.2.1 and 3.3.

1.7 CLASSIFICATION OF EXCAVATION

Excavation will be classified for the purpose of payment on the basis of the character of the materials removed and the methods employed for their removal as specified in the following paragraphs.

The Contractor shall excavate to the lines, grades, and slopes shown on the drawings or as otherwise specified or directed. When, during the progress of the excavation, material is encountered with respect to which the Contractor may claim classification as rock excavation, such material shall be uncovered and exposed for examination by the Contracting Officer, and the Contracting Officer notified by the Contractor, before proceeding further. The Contractor shall not proceed with the excavation of the material claimed as rock until the material in question has been classified by the Contracting Officer and cross-sectioned by the Contractor. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow ample time for cross-sectioning the undisturbed surface of such material, will forfeit the Contractor's right of claim to any classification other than earthwork as defined and paid under SECTION 02300: EARTHWORK. The classification of excavated material will be determined by the Contracting Officer. The excavation of earthen materials below top of rock, or excavation by ripping of materials below top of rock will not preclude payment for the excavated material under a classification of rock excavation.

1.7.1 Conventional Rock Excavation

The removal of all materials required to be excavated that require continuous systematic blasting, ripping, wedging, or hoe-ramming will be classified as rock excavation. This includes loose boulders and rocks 1 cubic yard or larger. It also includes soft rock and earthen materials encountered below top of rock as determined by the Contracting Officer. Limiting or prohibiting the use of explosives by these specifications or by the Contracting Officer will not preclude application of the classification of rock excavation to the removal of the material for which explosives otherwise would have been used. Guide holes and pre-blast reinforcement may be required to preserve the rock in some areas, for example at corners. The foundation excavation will proceed generally, and as far as practical, by benching from lower into higher areas. The Contractor may elect to use conventional methods to excavate all materials down to elevation 370. All material below elevation 370 shall be removed by the methods determined on the plans. Where the character of the materials and the methods of removal do not qualify a given volume of rock excavation for payment under one of the classes of specialized rock excavation, measurement and payment will be made for "Conventional Rock Excavation".

1.7.2 Controlled Rock Excavation.

Controlled rock excavation shall be defined as the excavation conducted with extraordinary care to ensure that the requirements imposed upon the excavation are met.

1.7.2.1 Buffer Zone Excavation

"Buffer Zone Excavation" shall be defined as excavation of rock, using the techniques specified below in paragraph, "Buffer Zone Excavation," in those areas which are shown on the plans and designated as a "Buffer Zone." The Contracting Officer may direct that additional areas be excavated using buffer zone techniques, in which case those areas will also be classified as "Buffer Zone Excavation".

1.7.2.2 Special Excavation

"Special Excavation" shall be defined as the excavation of rock, using the techniques specified below in paragraph, "Special Excavation" to a vertical surface against which the concrete for the various gate sills in the locks will be placed. Excavation of the rock thus defined will be classified as "Special Excavation".

1.7.2.3 Excavation Adjacent to Structures

"Excavation Adjacent to Structures" shall be defined as the excavation of rock, using the techniques specified below in paragraph, "Excavation Adjacent to Structures," in those areas which are shown on the plans and designated as "Excavation Adjacent to Structures." The Contracting Officer may direct that additional areas be excavated using these techniques, in which case those areas will also be classified as "Excavation Adjacent to Structures".

1.7.2.4 Failure to Meet Requirements

Failure on the part of the Contractor to meet the requirements imposed upon the controlled rock excavations will result in the Contractor forfeiting the right of claim to any classification other than "Conventional Rock Excavation".

1.8 Lock Operations During Contractor Work

All work by the Contractor will be adjacent to a lock continuously operated in the passage of waterway traffic. The Contractor's operations shall in no way interfere with these operations of the lock or adversely affect waterway traffic. The Contractor, therefore, must stop work, or take whatever measures are necessary to allow river traffic to pass through the locks uninterrupted. The Contractor must also meet the requirements in this Section, Paragraph 3.5.

1.9 Pre-Blast Public Meeting

***3**

The Contractor's representative, **The Blasting Specialist, The Blaster-In-Charge, and The Seismic Specialist** shall be present at the public meeting to be conducted as specified in Section 0800 of these specifications.

***3**

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 OVERBURDEN EXCAVATION

Overburden excavation shall be conducted as required in SECTION 02300: EARTHWORK.

3.2 BLASTING AND EXCAVATION IN ROCK

All blasting and excavation shall conform to the following; EM 1110-2-3800; ETL 1110-1-142; KRS; KAR; and Blaster's Handbook, 17th Edition. Excavation of the rock cut slopes shall be accomplished by special techniques and with special care, so that the remaining rock surfaces will be resistant to rock fall, adverse effects of weathering, and be fully competent for placement ***3** of concrete. **Blasting activities shall be conducted under the supervision of the Blaster-In-Charge in accordance with the approved Blasting Plan.** The Contractor shall take such precautions as are ***3** necessary to prevent cracking or damaging the rock or concrete outside the prescribed limits of excavation, and foundations or structures outside the limits of the excavation shall be left in a sound condition. These remaining surfaces shall be cut and dressed to plane surfaces by line drilling and presplitting excavation methods supplemented where and as necessary by hand and air tool dressing and trimming. No separate payment will be made for presplitting, cutting, dressing, and trimming the slopes, the costs for such work being included in the contract price for the rock excavation.

***1**
3.2.1 Preblast Survey

Prior to commencing drilling rock, masonry structures, or concrete structures, the Contractor shall complete and submit to the Contracting Officer a preblast survey which shall include at a minimum the following:

- **The 1200' lock chamber and all existing support structures,**
- **The south wall of the 600' lock chamber,**
- **All structures between the north wall of the auxiliary lock chamber and the 1200' lock chamber,**
- **All structures at the Louisville Repair Station,**

· All privately owned property and structures, as well as state and local government owned facilities in the area bounded by 22nd street, I-64, Portland Avenue, North Western Parkway, and the left descending bank of the Ohio River,
· The LG&E Swing Bridge over the 600' and 360' lock, its abutments and center support pier,
· The bascule bridge over the 1200' lock,
· The underground brick sanitary sewer within 1000 feet of any blasting,
· Any other underground or surface utilities within 1000 feet of any blasting.

The preblast survey should include the condition, type, construction, and condition of the exterior and interior of each structure, and shall also consider any sensitive equipment such as computers or electronic equipment, as well as fragile personal items. Still color photographs shall be used for visual documentation. The use of video cameras will not be permitted. The Contractor's blaster in charge shall be responsible for reviewing the preblast survey conducted for the project.

3.2.2 Historic Structures Near Project

The McAlpine site is located near historic structures and districts. The following historic structures are located near McAlpine; U.S. Marine Hospital at 2215 Portland Avenue; Greve, Buhrlage, and Company at 1501 Lytle Street; James F. Irvin House at 2910 Northwestern Parkway; Meek-Miller House at 3123 Northwestern Parkway; Montgomery Street School at 2500-2506 Montgomery Street; and Peaslee-Gaulbert Warehouse at 1427 Lytle Street. The following Historic Districts are located near McAlpine; The Portland Historic District, roughly bounded by Missouri Alley, Pflanz Avenue, Bank Street, North 33rd, and North 37th Streets; The Proposed Portland Avenue Extension of the Portland Historic District roughly bounded by Portland Avenue, 32nd Street, and Northwestern Parkway; and the Proposed Portland Avenue/N. 26th Street Historic District roughly bounded by Portland Avenue, 22nd Street, Lytle Street, Gilligan Alley, Xavier Street, and Bank Street. Historic structures and historic districts may be within the influence of blasting. Additional information regarding historic structures may be obtained by contacting the Planning Division, Environmental Analysis Branch of the Louisville District at (502)315-6900 or (502)315-6872. *1

3.3 TEST BLAST

At the beginning of blasting, a test blast section for each type of blasting in each lithological type shall be performed, and the pattern and charges shall be conservative to avoid damage beyond the blast limits. No excavation shall be taken to the excavation limits shown on the drawings, before the blasting techniques have been proven successful and approved by the Contracting Officer.

3.4 CONVENTIONAL EXCAVATION

Conventional excavation shall be understood to refer to the systematic drilling, loading, and firing of blast holes so as to break the rock mass into pieces small enough to be removed by standard excavating equipment.

Conventional excavation may be used for the removal of rock except for those locations which are scheduled for removal by alternate methods, as noted by the Excavation Method Plan or as directed by the Contracting Officer. Care shall be taken to prevent damage to the rock integrity outside the excavation limits, which will remain in place and provide structural stability, including presplit or line drilled faces. Additional requirements for production blasting are contained in paragraphs, "Buffer Zone Excavation," "Special Excavation," and "Excavation Adjacent to Existing Structures".

3.5 BLASTING

The Contractor shall closely coordinate his daily blasting operations with the Contracting Officer who will, in turn, coordinate with the project Lockmaster. No blasting shall be conducted when a barge is within the operating lock chamber. No blasting shall be conducted when a red-flag barge is within 1,000 feet upstream or downstream of the operating lock chamber. Prior to each blast the Contractor shall submit for the Contracting Officer's approval a plan detailing all the pertinent aspects of the blast design including the loading, firing, delay sequence, coordination of presplit and production blasting and special consideration. The Contractor's plan shall show the location and depth of holes, type of explosive, inclination of wedge cut holes, amount and strength of explosives per hole and length of pull per blast. All blasting operations shall be subject to the approval of the Contracting Officer. The depth and the spacing of the blast holes shall be determined by observation of the manner in which the rock breaks in the Test Blasting and as the operations progress. Lift heights shall be limited to a maximum of twenty (20) feet. Blast holes other than holes used for presplitting shall not be drilled to depths greater than 2/3 the depth to grade, except that drilling to full depth may be permitted where that depth is less than seven (7) feet, provided that the bottom of the hole is padded with at least 6-inches of sand. When blasting near concrete structures, the Contractor shall conform to requirements in this Section, Paragraph 3.11.

The Contractor shall take such precautions as are necessary to prevent cracking or damaging the rock outside the prescribed limits of excavation, so the rock outside the limits of the excavation shall remain as sound and undamaged as possible. All presplit and production blasting shall be initiated by a nonelectric method such as the shock tube initiation system. The use of bulk explosives such as ammoniated prills will not be permitted during the excavation for the foundations of the various concrete structures unless positive measures are taken to prevent its mixing with water and the uncontrolled spread of the blasting agent into subsurface cracks, caverns, or cavities. Approval of the method of blasting by the Contracting Officer shall not relieve the Contractor of his responsibility for his blasting operations. When the Contractor sees fit, or the Contracting Officer so directs, the Contractor shall cover all shots in open cut excavations.

3.6 PRESPLITTING

Presplitting shall be performed in accordance with the methods proposed by the Contractor and approved by the Contracting Officer or his authorized representative. Presplit holes shall be 2-1/2- to 3-inches in diameter, spaced 18- to 24-inches center to center, except where concrete is to be placed against the presplit faces the spacing of the holes shall not exceed 18 inches center to center. The holes shall be drilled no deeper than the required final elevation of the excavation. Presplit holes shall be drilled with equipment which is capable of maintaining the alignment and plane of the presplit pattern throughout the full depth of the drilled holes. The holes shall not vary by more than 1 degree in any direction from the intended plane. Presplitting shall be performed on all final lines and grades which are to remain for concrete placement. Locations of presplit holes shall be such that the 95% of the holes shall be within one hole diameter of the staked location. Presplitting shall be performed in such a manner that all faces and floors remaining will be undisturbed rock, and that the faces and floors shall be within 6 inches of the lines and grades established in the plans or directed by the Contracting Officer. Except that where concrete is to be placed against the presplit face, the rock shall not project inside the neat lines shown on the drawings for the concrete structure. The Contractor should be aware that the excavation will require presplitting many inside and outside corners which may necessitate a modification of the drilling pattern or the use of unloaded guide holes to prevent overbreakage. Unloaded and unstemmed guide holes, when used between presplit holes, shall be of the same diameter and in the same plane and to the same tolerance as the presplit holes. All presplitting for final monolith configuration shall extend to final grade except in intermediate lifts, where set back is necessary to achieve final monolith grade.

3.7 STEMMING

Variations from hard to soft rock with depth will require the Contractor to stem the blast holes through soft rock areas so care should be taken in classifying the rock while drilling the blast holes. Holes shall be stemmed with crushed limestone having a maximum size of 3/8-inch. Drill cuttings, clay, pea gravel, sand, or dirt shall not be used as stemming. No separate payment will be made for stemming.

#3

3.8 SCALING

For safety reasons, the Contractor will be required to scale any loose material remaining on the vertical excavation face. The work shall be done immediately after each lift of the interior rock mass is removed by production blasting. The removal shall be accomplished by compressed air or water jetting, pry bars, rock picks, and/or other means as approved by the Contracting Officer. No separate payment shall be made for scaling. **Scaling is different from final foundation preperation, which is specified and paid under SECTION 02217: Foundation Preperation.**

#3

3.9 LINE DRILLING

Line drilling shall be performed in accordance with the methods proposed by the Contractor and approved by the Contracting Officer or his authorized representative. Line drilled holes shall be 2- to 3-inches in diameter. The spacing of the drilled holes shall not be more than twice the hole diameter, center to center, along the excavation lines as shown on the drawings. The holes shall not vary by more than 1 degree in any direction from the intended plane. The line drilled holes shall be drilled with equipment capable of maintaining the alignment and plane of the of the drilled hole throughout the full depth of the holes. Locations of presplit holes shall be such that the 95% of the holes shall be within one hole diameter of the staked location. Line drilling shall be performed in such a manner that the faces remaining shall be undisturbed rock, and that the faces shall not project inside the excavation lines as shown on the drawings. Line drilling shall be performed on all outside corners of foundation excavation or as directed by the Contracting Officer. From an outside corner, a minimum of 3-feet on each adjacent remaining face, as well as 3-feet past the corner into rock to be removed, shall be line drilled. Line drilling or guide holes shall be utilized while blasting inside corners to ensure the remaining rock faces are intact and competent.

3.10 BUFFER ZONE EXCAVATION

"Buffer zone excavation" shall be understood to refer to the excavation, using the specified techniques, of those areas which are shown on the plans and designated as a "Buffer Zone." Blasting in these areas shall not be performed until a relief zone is provided in front of the shot which is designed to remove the buffer zone. Where special excavations and buffer zone excavations lie adjacent to each other, the buffer zone excavation shall be completed before the special excavation at any given elevation.

3.10.1 Buffer Zone Dimensions

The buffer zone shall be a section of rock the width of which is measured perpendicular to the cutslope which will remain after the buffer zone excavation. The width of the buffer zone shall be fifteen feet, unless otherwise shown on the drawings or specified in paragraph, Relief Zone. The buffer zone shall extend across the full length of the monolith parallel to the cutslope which will remain after the excavation of the buffer zone. The buffer zone shall extend from top of rock down to the founding elevation of the monolith at the location of the buffer zone.

3.10.2 Buffer Zone Blast Design

Blast design for those areas designated for buffer zone excavation shall be such that the least amount of explosives is used, commensurate with loading and hauling by conventional equipment. The fragmentation shall be such that additional effort and care must be taken in the removal of the blasted material to prevent an inordinate amount of wear and tear to the equipment. The experience base to be used for determining the proper amount of explosives shall be gained through test blasting during the excavation of the adjacent materials which are not scheduled for buffer zone excavation. The Contractor shall propose test blasts to determine appropriate buffer zone blast designs through submittal of plans to the Contracting Officer. Trial and error methods shall not be used while conducting the buffer zone excavation itself. Conventional presplit methods are considered to be adequate for the purposes at hand, provided that complete relief is available for any and all buffer zone shots. Failure to provide complete relief for the buffer zone excavations may result in the need to revise base widths and or excavation limits. The depth of each blast in the buffer zone shall be limited to 20-feet or less and no subdrilling will be permitted.

3.10.3 Relief Zone

The relief zone which is to be provided shall extend to the full depth and width of the blast and for a minimum distance of at least 10 feet in front of the blast. If as the work progresses it becomes necessary, the Contractor shall expand the relief as may be required to provide total relief for the shot and prevent damage to the remaining cutslope. Where buffer zones are shown for both faces of a monolith excavation and, in the opinion of the Contracting Officer, the resulting limitations in work space preclude the use of buffer zone techniques as herein specified, the width of the buffer zone shall be cut in half. Where the buffer zone has been reduced in width because of space limitations, the preceding shots to provide a relief zone shall be presplit and delayed in a "V" pattern and additional care shall be taken to ensure that the rock in the buffer zone is not damaged.

3.10.4 Initial Shots to Depth

Where initial shots are required to reach a given depth for the first time in a given area, these shots shall be carefully designed and located to prevent damage to the buffer zone and future presplit faces. Final presplit lines shall not be shot with these initial shots to depth but shall be made when sufficient relief has been provided to prevent damage by the presplit blasting.

3.10.5 Buffer-Zone Presplit

Presplit lines which are required for the buffer zone excavation shall be drilled, loaded, and shot along with their respective buffer zone, except that when full depth relief is provided, the presplit may be drilled and shot to the full depth of the excavation. Where relief is not provided for the full depth of the excavation and presplit blasting is required for each lift, the Contractor shall be responsible for setting back the upper presplit lines to provide for the neat line configuration shown on the plans. Where setting back is necessary the Contractor shall replace that material outside the neat line with appropriate concrete at his own expense.

3.10.6 Special Excavation

Excavation of those areas on or against which the concrete for the various lock gate sills and culverts will be placed will require specialized procedures to protect the rock that will remain in place. Special excavation in the locks shall consist of light blasting supplemented by mechanical methods so that fragmentation will not be the controlling factor in the design of the blast. The blast shall be designed so that the rock is broken but the fragment size is such that removal by conventional excavating equipment is not possible without the use of supplementary mechanical methods such as hydraulic rock splitters, impact hammers, or boom-mounted demolition hammers such as those manufactured by Kent Demolition Tools, 711 Lake St., Kent, Ohio or equal. Special excavation in the locks shall be performed in a manner such that the surfaces against which the lock sills and culverts are to be placed are free from defects caused by the excavation methods, and such that the pre-existing defects in the rock will not be aggravated by the method of excavation. Where special excavations in the locks and buffer zone excavations lie adjacent to each other, the buffer zone excavation shall be completed before the special excavation at any given elevation. Additional requirements for special excavation are contained in paragraphs, Line Drilling, and Buffer Zone Excavation.

***3**

3.11 EXCAVATION ADJACENT TO EXISTING STRUCTURES

Excavation adjacent to structures shall be performed with extra care in order to ensure that the materials remaining after the excavation are undamaged by the excavation process. In order to accomplish this the backwall of the excavation shall be line drilled. After line drilling the excavation shall be performed using boom-mounted demolition hammers and other non-explosive type excavation techniques. The minimum required width for this zone of excavation is five feet measured at right angles to the face which will remain after the excavation. No blasting of any kind shall be performed within 100 feet of any concrete or grout that is less than 14 days old nor concrete or grout that has not achieved 1000 psi compressive strength. Blasting within 50 feet of any concrete shall be performed using line drilling, presplit, blasting mats, or other measures as identified in the Blasting Plan to prevent damage to the concrete. Blasting conducted near the existing 600-foot lock shall not cause damage to the concrete structure or cause rock beneath its foundation to become loose and undermine its foudation. No blasting of any kind shall be performed within 25 feet of the swing bridge or its abutments until the new fixed bridge is constructed and in service and the swing bridge is taken out of operation. **This zone of no blasting includes the entire cylindrical volume of rock both horizontally and vertically within the 25-foot zone around the swing bridge structures. If this zone falls within a monolith excavation, mechanical methods and any other such non-explosive excavation method shall be used to excavate this zone to full foundation elevation. Procedures shall be such to ensure great care shall be taken so no damage is imposed on the swing bridge pier and abutments during blasting and excavation.**

***3**

3.12 OVEREXCAVTION AND REFILL

3.12.1 Overexcavation

Where overexcavation and subsequent refill in a vertical wall are made necessary through fault or negligence on the part of the Contractor no additional payment will be made for the excavation or refill. Where overexcavation and subsequent refill in a vertical wall is made necessary through no fault or negligence on the part of the Contractor, the excavation and refill will be paid for at contract unit prices. In order to receive payment under this item the Contractor must clearly demonstrate that there was a pre-existing defect in the rock which caused the overexcavation, or that the overexcavation was necessary for the safety of the workmen. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow ample time for cross-sectioning the undisturbed surface of such material, will forfeit the Contractor's right of claim to any classification other than "Earthwork".

3.12.2 Refill

Refill in a vertical wall made necessary by overexcavation which is not due to fault or negligence on the part of the Contractor will be paid for under contract unit prices in SECTION 03700: MASS CONCRETE. The Contracting Officer will direct whether the refill material will consist of lean concrete or backfill materials similar to the adjacent backfill materials. Concrete placements made necessary under this provision shall not qualify for payment as dental treatment. Any additional refill and forming the surface between the monolith concrete and rock excavation made necessary by overexcavation shall be solely performed at the Contractor's expense.

3.13 DRESSING AND TRIMMING

Loose, fractured, or projecting rock shall be removed from the slopes by picking, barring, air tooling, or light blasting. Excavated surfaces shall be washed down with water prior to placement of the adjacent concrete, as specified in Section, CONCRETE.

3.14 DISPOSAL OF ROCK MATERIALS

All disposal of rock materials shall be conducted in an off-site disposal areas as approved by the Contracting Officer. The Contractor shall be responsible for obtaining all proper permits and meet disposal requirements of SECTION 1410: Environmental Protection, and the requirements of the disposal facility.

3.15 STORAGE AND USE OF EXPLOSIVES

General. Explosives shall not be stored at the site overnight. The Contractor shall store explosives at an offsite location and transport the explosives to the site daily, as needed. Explosives shall be stored, handled, and used in accordance with the best practice as approved by the Contracting Officer and in accordance with all Federal, state, and local laws and regulations. The Contractor shall comply with all special rules and regulations that may be made by the authorities having jurisdiction, or by the Contracting Officer, regarding construction of and storage in magazines, precautions in blasting, and the like. The Contractor will be responsible for all claims for damage caused by or arising out of the blasting. All blasting operations shall be performed in accordance with the current edition of EM 385-1-1, Safety and Health Requirements Manual.

3.15.1 Magazines

Explosives shall be stored in suitable magazines in an approved location. Detonators shall be kept in a separate magazine. Each magazine shall have around it a cleared area suitably barricaded and maintained so that fire cannot spread to the magazine area.

3.15.2 Magazine Keeper

Each magazine keeper shall be competent, trustworthy, sober, and familiar with the laws and general practices concerning the handling, care, use, and storage of explosives and detonators. The magazine keeper shall also be responsible for maintaining a cleared area around each magazine. No magazine keeper shall be required to perform any duties that will in any way interfere with his duties as magazine keeper.

3.15.3 Blasting Specialist

The Contractor shall employ a qualified blasting specialist experienced and trained in the types of blasting required in this Section. The blasting specialist must have at least five years of experience in blasting specifically applicable to this job.

3.15.4 Daily Records

Accurate daily records shall be kept by the magazine keepers who shall account for each piece of explosive, detonator, and equipment from the time of delivery at the magazine until its discharge in use. No explosive shall be accepted until it has been plainly labelled and delivered as new stock in sound condition. Containers for explosives shall be approved in advance by the Contracting Officer. Drilling and blasting operations shall be conducted at such times and under such restrictions and conditions as the Contracting Officer approves.

3.16 BLAST VIBRATION MONITORING

General. Vibration monitoring of all blasts is required of the Contractor. The blasts shall be monitored to ensure that the peak particle velocity measured at the nearest structure outside the Contractor's work area and at the swing bridge pier does not exceed 1 inch per second, and that the peak particle velocity measured at the nearest structure within the Contractor's work area does not exceed 4 inches per second.

3.16.1 Charge Weight

Charge Weight. The maximum charge weight per delay can be approximated by the use of the following equation which will require refinement based on experience gained as the work progresses:

$\log W = 1.25 \log V - 2.7551 + 2 \log R$, where

V = peak particle velocity, in inches per second

R = shortest distance between blast and the point of interest, in feet

W = maximum weight of explosives per delay period of eight milliseconds or more, in pounds.

3.16.2 Seismic Specialist

The Contractor shall employ a qualified seismic specialist trained in vibration control methods and capable of analyzing results obtained from blasting seismographs.

3.16.3 Measuring and Recording Instruments

The Contractor shall provide at least four (4) instruments within the Contractor's work limits and a minimum of two (2) instruments outside the Contractor's work limits. The instruments shall meet with specifications equal to the Series II or higher, seismometer, available from Instantel or equal. Within the Contractor's work limits, one seismometer shall be on the swing bridge pedestal, located on a side closest to blasting activities, and one seismometer shall be on the north-middle wall of the operating lock, located adjacent to any blasting activities. Outside the Contractor's work limits, the seismometers shall be placed to monitor blasting effects on the Louisville Gas and Electric Company facility to the north and the Portland Community to the south. The units must be self-contained except for external geophones and microphones, and must be capable of providing a printout of each blast. The units shall be programmed with specific data on each site of placement. The Contractor shall also provide a minimum of two (2) airblast recorders.

3.16.4 Seismograph Operator

The seismograph operator shall be a qualified person capable of setting the instrument up at designated locations and effectively recording the blast.

3.16.5 Results of Monitoring

The original printed results of vibration monitoring in the form of peak readings and frequencies for each blast shall be presented to the Contracting Officer prior to any further drilling or blasting. The original records shall be maintained by the Contractor and copies shall be provided to the Contracting Officer. No drilling or blasting shall be conducted before the results from the previous blasting have been furnished to the Contracting Officer. Instruments that provide only peak readings from an analog view-meter type display will not be acceptable. Results in the form of peak readings will be acceptable provided they are obtained from the vibration record and not from a separate device as previously mentioned. The Contractor shall take all necessary precautions to assure that the peak readings available from the vibration record are accurate to the maximum extent possible, as defined by the manufacturer of the equipment. On an annual basis, and more often if necessary, the equipment, including peak readout, shall be certified by the manufacturer to be within acceptable calibration limits. In addition, the airblast limit associated with blasting activities shall not exceed 133 decibels.

3.17 CLEARING OF MISFIRES

The Contracting Officer shall be notified immediately of any misfire and all work in the area shall be stopped. The blast area should then be cleared in accordance with the industry standards, and in accordance with the explosive manufacturer's recommendations. The misfire shall be cleared ***3** by the **Blaster-In Charge**. Only the individuals necessary for clearing ***3** the misfire shall be present until the misfire is cleared. The misfire shall be documented with the blast record including the manner in which the misfire was cleared and any corrective actions.

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DIVISION 02 - SITE WORK

SECTION 02240

SANDSTONE BENCHES AND BOLLARDS

11/01

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SECTION 02240

SANDSTONE BENCHES AND BOLLARDS
11/01

PART 1 GENERAL

1.1 SCOPE OF WORK

Sandstone to be used for this project was previously removed from existing work and stock piled at the site. The Contracting Officer will direct the contractor where to obtain the stone. Contractor shall cut and grind the sandstone for benches and bollards as detailed on the drawings.

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-04 Drawings

Cutting and Grinding stone; GA, ED.

Detail drawings showing individual stones to be cut and ground smooth for the intended uses.

SD-18 Records

Work Plan; GA, ED.

The procedures proposed for the accomplishment of the work. The procedures shall provide for safe conduct of the work, careful removal and disposition of materials to be relocated, and coordination with other work in progress. The procedures shall include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations.

1.3 QUALIFICATIONS

Contractor shall list similar projects where movement and placement of large stones was performed. A current point-of-contact for identified references shall be provided. The Contractor shall provide qualified workers trained and experienced in cutting, polishing, handling large blocks of stone.

1.4 MEASUREMENT AND PAYMENT

***3**

The measurement for the Sandstone Benches and Bollards shall be lump sum. Payment for all work covered under this section will be made at the contract lump sum price for "Sandstone Benches and Ballards" as listed in the bidding schedule. *3

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 CUTTING AND GRINDING OF SANDSTONE

***1**

Sandstone shall require cutting and grinding smooth to the configurations shown on the drawings, for use as stone bollards, and a stone benches. **For the Visitor Overlook** bollards, provisions for conduit, recessed walk lights and audio fixtures shall made based upon approved shopdrawings (see section 16800 AUDIO SYSTEM and section 16528 EXTERIOR LIGHTING, for requirements). Cutting and grinding smooth process shall be performed in a factory.***1**

3.2 INSTALLATION

***1**

Sandstone bollards **for the Visitor Overlook** shall be set on stainless steel dowels and setting pads in a full bed of non-shrink grout. Coordinate audio and electrical conduit connections as required. **Other bollards shall be installed as indicated.** Stone benches shall be placed on setting pads and concrete foundation as indicated on the drawings.***1**

3.3 CLEAN-UP

Upon completion of the work, portions of structure to remain and adjacent areas and structures shall be cleaned of dust, dirt, and debris caused by salvage and demolition operations. Debris and rubbish shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply. The Contractor shall comply with the waste disposal requirements outlined in Section 01410, ENVIRONMENT PROTECTION.

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DIVISION 02 - SITE WORK

SECTION 02741

HOT-MIX ASPHALT (HMA) FOR ROADS

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SECTION 02741

HOT-MIX ASPHALT (HMA) FOR ROADS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO TP53	(1995) Determining Asphalt Content of Hot Mix Asphalt by the Ignition Method

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 566	(1997) Total Evaporable Moisture Content of Aggregate by Drying
ASTM D 140	(1998) Sampling Bituminous Materials
ASTM D 242	(1995) Mineral Filler for Bituminous Paving Mixtures
ASTM D 995	(1995b) Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
ASTM D 1461	(1985; R 1994) Moisture or Volatile Distillates in Bituminous Paving Mixtures
ASTM D 1559	(1989) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D 2041	(1995) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 2172	(1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures

ASTM D 2489	(1984; R 1994) Degree of Particle Coating of Bituminous-Aggregate Mixtures
ASTM D 2726	(1996a) Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixture
ASTM D 2950	(1997) Density of Bituminous Concrete in Place by Nuclear Method
ASTM D 3665	(1994) Random Sampling of Construction Materials
ASTM D 3666	(1996a) Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials
ASTM D 4125	(1994) Asphalt Content of Bituminous Mixtures by the Nuclear Method
ASTM D 4867	(1996) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D 5444	(1994) Mechanical Size Analysis of Extracted Aggregate
ASTM D 6307	(1998) Asphalt Content of Hot Mix Asphalt by Ignition Method
KYTC	(2000) Kentucky Transportation Cabinet/Department of Highways Standard Specifications for Road and Bridge Construction

ASPHALT INSTITUTE (AI)

AI MS-2	(1994) Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types

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1.2 DESCRIPTION OF WORK

The work shall consist of pavement courses composed of mineral aggregate and asphalt material heated and mixed in a central mixing plant and placed on a prepared course. HMA designed and constructed in accordance with this section shall conform to the lines, grades, thicknesses, and typical cross sections shown on the drawings. Each course shall be constructed to the depth, section, or elevation required by the drawings and shall be rolled, finished, and approved before the placement of the next course. Pavement shall not be placed for a distance of 100 feet directly south of monoliths L2 and L17 until embankment fill material has reached an age of six months.

The Contractor shall perform asphalt paving operations in compliance with Air Pollution Control District of Jefferson County Regulation 7.11, Standard of Performance for New Asphalt Paving Operations.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals not having a "GA" designation are for information only, "FIO". When used, a designation following the "GA" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-09 Reports

Aggregates; GA, RE.

QC Monitoring; FIO.

Aggregate and QC test results; FIO

SD-13 Certificates

Asphalt Cement Binder; GA, RE

Copies of certified test data; FIO
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Testing Laboratory; **GA, RE**
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Certification of compliance; FIO

Plant Scale Calibration Certification; FIO

SD-14 Samples

Asphalt Cement Binder; FIO

(5 gallon) sample for mix design verification.

Aggregates; FIO

Sufficient materials to produce 200 lb of blended mixture for mix design verification.

SD-18 Records

Mix Design; GA, RE.

Proposed JMF; GA, RE.

Contractor Quality Control; GA, RE.

Quality control plan; GA, RE.

Material Acceptance and Percent Payment;;GA, RE.

Acceptance test results and pay calculations; GA, RE.

1.4 METHOD OF MEASUREMENT

The amount paid for will be the number of tons of hot-mix asphalt mixture used in the accepted work. Hot-mix asphalt mixture shall be weighed after mixing, and no separate payment will be made for weight of asphalt cement material incorporated herein.

1.5 BASIS OF PAYMENT

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Quantities of surface-course and binder-course mixtures, determined as specified above, will be paid for at **the contract unit price for tons of hot-mix asphalt mixture used in the accepted work**. Payment shall constitute full compensation for furnishing all materials, equipment, plant, and tools; and for all labor and other incidentals necessary to complete work required by this section of the specification.

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1.6 ASPHALT MIXING PLANT

Plants used for the preparation of hot-mix asphalt shall conform to the requirements of ASTM D 995 with the following changes:

a. Truck Scales. The asphalt mixture shall be weighed on approved certified scales at the Contractor's expense. Scales shall be inspected and sealed at least annually by an approved calibration laboratory.

b. Testing Facilities. The Contractor shall provide laboratory facilities at the plant for the use of the Government's acceptance testing and the Contractor's quality control testing.

c. Inspection of Plant. The Contracting Officer shall have access at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; checking the temperatures maintained in the preparation of the mixtures and for taking samples. The Contractor shall provide assistance as requested, for the Government to procure any desired samples.

d. Storage Bins. Use of storage bins for temporary storage of hot-mix asphalt will be permitted as follows:

(1) The asphalt mixture may be stored in non-insulated storage bins for a period of time not exceeding 3 hours.

(2) The asphalt mixture may be stored in insulated storage bins for a period of time not exceeding 8 hours. The mix drawn from bins shall meet the same requirements as mix loaded directly into trucks.

1.7 HAULING EQUIPMENT

Trucks used for hauling hot-mix asphalt shall have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Petroleum based products shall not be used as a release agent. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers (tarps) shall be securely fastened.

1.8 ASPHALT PAVERS

Asphalt pavers shall be self-propelled, with an activated screed, heated as necessary, and shall be capable of spreading and finishing courses of hot-mix asphalt which will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface.

1.8.1 Receiving Hopper

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

1.8.2 Automatic Grade Controls

If an automatic grade control device is used, the paver shall be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. A transverse slope controller shall not be used to control grade. The controls shall be capable of working in conjunction with any of the following attachments:

a. Ski-type device of not less than 30 feet in length.

b. Taut stringline set to grade.

c. Short ski or shoe for joint matching.

d. Laser control.

1.9 ROLLERS

Rollers shall be in good condition and shall be operated at slow speeds to avoid displacement of the asphalt mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. Equipment which causes excessive crushing of the aggregate shall not be used.

1.10 WEATHER LIMITATIONS

For limitation see KYTC Section 403.03.01.

PART 2 PRODUCTS

2.1 AGGREGATES

Aggregates shall conform to KYTC Section 403.

2.1.1 Course Aggregate

Coarse aggregate shall conform to KYTC Section 805.

2.1.2 Fine Aggregate

Fine aggregate shall conform to KYTC 804.

2.1.3 Mineral Filler

Mineral filler shall be nonplastic material meeting the requirements of ASTM D 242.

2.1.4 Aggregate Gradation

The combined aggregate gradation shall conform to gradations specified in KYTC Sections 804 and 805.

2.2 ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to KYTC Section 806. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Contracting Officer. The supplier is defined as the last source of any modification to the binder. The Contracting Officer may sample and test the binder at the mix plant at any time before or during mix production. Samples for this verification testing shall be obtained by the Contractor in accordance with ASTM D 140 and in the presence of the Contracting Officer. These samples shall be furnished to the Contracting Officer for the verification testing, which shall be at no cost to the Contractor. Samples of the asphalt cement specified shall be submitted for approval not less than 14 days before start of the test section.

2.3 MIX DESIGN

The Contractor shall develop the mix design. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the Job Mix Formula (JMF). No hot-mix asphalt for payment shall be produced until a JMF has been approved. The hot-mix asphalt shall be designed using procedures contained in AI MS-2 and the criteria shown in Table 1. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D 4867 is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. If an antistrip agent is required, it shall be provided by the Contractor at no additional cost. Sufficient materials to produce 200 pound of blended mixture shall be provided to the Contracting Officer for verification of mix design at least 14 days prior to construction of test section.

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2.3.1 JMF Requirements

The job mix formula shall be submitted in writing by the Contractor for approval at least 14 days prior to the start of the test section and shall include as a minimum:

a. Percent passing each sieve size.

b. Percent of asphalt cement.

c. Percent of each aggregate and mineral filler to be used.

d. Asphalt viscosity grade, penetration grade, or performance grade.

e. Number of blows of hammer per side of molded specimen.

f. Laboratory mixing temperature.

g. Lab compaction temperature.

h. Temperature-viscosity relationship of the asphalt cement.

i. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.

j. Graphical plots of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-2.

k. Specific gravity and absorption of each aggregate.

l. Percent natural sand.

m. Percent particles with 2 or more fractured faces (in coarse aggregate).

n. Fine aggregate angularity.

o. Percent flat or elongated particles (in coarse aggregate).

p. Tensile Strength Ratio(TSR).

q. Antistrip agent (if required) and amount.

r. List of all modifiers and amount.

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Table 1. Marshall Design Criteria

Test Property	50 Blow Mix
Stability, pounds minimum	**1500**
Flow, 0.01 inch	8-18
Air voids, percent	3-5
Percent Voids in mineral aggregate VMA, (minimum)	
Asphalt Binder Course	**14.5**
Asphalt Surface Course	**15.5**
TSR, minimum percent	75

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2.3.2 Adjustments to Field JMF

The Laboratory JMF for each mixture shall be in effect until a new formula is approved in writing by the Contracting Officer. Should a change in sources of any materials be made, a new laboratory jmf design shall be performed and a new JMF approved before the new material is used. The Contractor will be allowed to adjust the Laboratory JMF within the limits specified below to optimize mix volumetric properties with the approval of the Contracting Officer. Adjustments to the Laboratory JMF shall be applied to the field (plant) established JMF and limited to those values as shown. Adjustments shall be targeted to produce or nearly produce 4 percent voids total mix (VTM).

TABLE 2. Field (Plant) Established JMF Tolerances

Sieves	Adjustments (plus or minus), percent
No. 4	3
No. 8	3
No. 200	1
Binder Content	0.40

If adjustments are needed that exceed these limits, a new mix design shall be developed. Tolerances given in Table 2 may permit the aggregate grading to be outside the limits shown in KYTC Sections 804 and 805; while not desirable, this is acceptable.

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2.4 **NOT USED**
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PART 3 EXECUTION

3.1 PREPARATION OF ASPHALT BINDER MATERIAL

The asphalt cement material shall be heated avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of unmodified asphalts shall be no more than 325 degrees F when added to the aggregates. Modified asphalts shall be no more than 350 degrees F when added to the aggregates.

3.2 PREPARATION OF MINERAL AGGREGATE

The aggregate for the mixture shall be heated and dried prior to mixing. No damage shall occur to the aggregates due to the maximum temperature and rate of heating used. The temperature of the aggregate and mineral filler shall not exceed 350 degrees F when the asphalt cement is added. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

3.3 PREPARATION OF HOT-MIX ASPHALT MIXTURE

The aggregates and the asphalt cement shall be weighed or metered and introduced into the mixer in the amount specified by the JMF. The combined materials shall be mixed until the aggregate obtains a uniform coating of asphalt binder and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but no less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D 2489, for each individual plant and for each type of aggregate used. The wet mixing time will be set to at least achieve 95 percent of coated particles. The moisture content of all hot-mix asphalt upon discharge from the plant shall not exceed 0.5 percent by total weight of mixture as measured by ASTM D 1461.

3.4 PREPARATION OF THE UNDERLYING SURFACE

Immediately before placing the hot mix asphalt, the underlying course shall be cleaned of dust and debris. A prime coat and tack coat shall be applied in accordance with the contract specifications.

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3.5 **NOT USED**
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3.6 TESTING LABORATORY

The laboratory used to develop the JMF shall meet the requirements of ASTM D 3666. A certification signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer prior to the start of construction. The certification shall contain as a minimum:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

3.7 TRANSPORTING AND PLACING

3.7.1 Transporting

The hot-mix asphalt shall be transported from the mixing plant to the site in clean, tight vehicles. Deliveries shall be scheduled so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Adequate artificial lighting shall be provided for night placements. Hauling over freshly placed material will not be permitted until the material has been compacted as specified, and allowed to cool to 140 degrees F. To deliver mix to the paver, the Contractor shall use a material transfer vehicle which shall be operated to produce continuous forward motion of the paver.

3.7.2 Placing

The mix shall be placed and compacted at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. Upon arrival, the mixture shall be placed to the full width by an asphalt paver; it shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the asphalt mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a ***3** crowned section or on the **low** side of areas with a one-way slope. The ***3** mixture shall be placed in consecutive adjacent strips having a minimum width of 10 feet. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 1 foot; ***3** however, the joint in the surface course shall be **along the dividing line between the lanes**. Transverse joints in one course shall be offset ***3** by at least 10 feet from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet. On isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools.

3.8 COMPACTION OF MIXTURE

After placing, the mixture shall be thoroughly and uniformly compacted by rolling. The surface shall be compacted as soon as possible without causing displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once. Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened but excessive water will not be permitted. In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers. Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective shall be removed full depth, replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching will not be allowed.

3.9 JOINTS

The formation of joints shall be made ensuring a continuous bond between the courses and to obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

3.9.1 Transverse Joints

The roller shall not pass over the unprotected end of the freshly laid mixture, except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing material at the joint . The cutback material shall be removed from the project. In both methods, all contact surfaces shall be given a light tack coat of asphalt material before placing any fresh mixture against the joint.

3.9.2 Longitudinal Joints

Longitudinal joints which are irregular, damaged, uncompacted, cold (less than 175 degrees F at the time of placing adjacent lanes), or otherwise defective, shall be cut back a minimum of 2 inches from the edge with a cutting wheel to expose a clean, sound vertical surface for the full depth of the course. All cutback material shall be removed from the project. All contact surfaces shall be given a light tack coat of asphalt material prior to placing any fresh mixture against the joint.

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3.10 CONTRACTOR QUALITY CONTROL

3.10.1 General Quality Control Requirements

The Contractor shall develop an approved Quality Control Plan. Hot-mix asphalt for payment shall not be produced until the quality control plan has been approved. The plan shall address all elements which affect the quality of the pavement including, but not limited to:

a. Mix Design

b. Aggregate Grading

c. Quality of Materials

d. Stockpile Management

e. Proportioning

f. Mixing and Transportation

g. Mixture Volumetrics

h. Moisture Content of Mixtures

i. Placing and Finishing

j. Joints

k. Compaction

l.Surface Smoothness

3.10.2 Testing Laboratory

The Contractor shall provide a fully equipped asphalt laboratory located at the plant or job site. The laboratory shall meet the requirements as required in ASTM D 3666. The effective working area of the laboratory shall be a minimum of 150 square feet with a ceiling height of not less than 7.5 feet. Lighting shall be adequate to illuminate all working areas. It shall be equipped with heating and air conditioning units to maintain a temperature of 75 degrees F plus or minus 5 degrees F. Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Contracting Officer shall be permitted unrestricted access to inspect the Contractor's laboratory facility, to witness quality control activities, and to perform any check testing desired. The Contracting Officer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are corrected.

3.10.3 Quality Control Testing

The Contractor shall perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. The testing program shall include, but shall not be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the asphalt mixture, laboratory air voids, stability, flow, in-place density, grade and smoothness. A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

3.10.3.1 Asphalt Content

A minimum of two tests to determine asphalt content will be performed per ***3** lot (a lot is defined in paragraph MATERIAL ACCEPTANCE) by one of ***3** the following methods: the extraction method in accordance with ASTM D 2172, Method A or B, the ignition method in accordance with the AASHTO TP53 or ASTM D 6307, or the nuclear method in accordance with ASTM D 4125, provided the nuclear gauge is calibrated for the specific mix being used. For the extraction method, the weight of ash, as described in ASTM D 2172, shall be determined as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture.

3.10.3.2 Gradation

Aggregate gradations shall be determined a minimum of twice per lot from mechanical analysis of recovered aggregate in accordance with ASTM D 5444. When asphalt content is determined by the nuclear method, aggregate gradation shall be determined from hot bin samples on batch plants, or from the cold feed on drum mix plants. For batch plants, aggregates shall be tested in accordance with ASTM C 136 using actual batch weights to determine the combined aggregate gradation of the mixture.

3.10.3.3 Temperatures

Temperatures shall be checked at least four times per lot, at necessary locations, to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

3.10.3.4 Aggregate Moisture

The moisture content of aggregate used for production shall be determined a minimum of once per lot in accordance with ASTM C 566.

3.10.3.5 Moisture Content of Mixture

The moisture content of the mixture shall be determined at least once per lot in accordance with ASTM D 1461 or an approved alternate procedure.

3.10.3.6 Laboratory Air Voids, Marshall Stability and Flow

Mixture samples shall be taken at least four times per lot and compacted into specimens, using 50 blows per side with the Marshall hammer as described in ASTM D 1559. After compaction, the laboratory air voids of each specimen shall be determined, as well as the Marshall stability and flow.

3.10.3.7 In-Place Density

The Contractor shall conduct any necessary testing to ensure the specified density is achieved. A nuclear gauge may be used to monitor pavement density in accordance with ASTM D 2950.

3.10.3.8 Grade and Smoothness

The Contractor shall conduct the necessary checks to ensure the grade and smoothness requirements are met in accordance with paragraph MATERIAL
***3** ACCEPTANCE. ***3**

3.10.3.9 Additional Testing

Any additional testing, which the Contractor deems necessary to control the process, may be performed at the Contractor's option.

3.10.3.10 QC Monitoring

The Contractor shall submit all QC test results to the Contracting Officer on a daily basis as the tests are performed. The Contracting Officer reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

3.10.4 Sampling

When directed by the Contracting Officer, the Contractor shall sample and test any material which appears inconsistent with similar material being produced, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

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3.10.5 **NOT USED**

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***3** 3.11 MATERIAL ACCEPTANCE ***3**

Testing for acceptability of work will be performed by an independent laboratory hired by the Contractor. Test results and payment calculations shall be forwarded daily to the Contracting Officer. Acceptance of the plant produced mix and in-place requirements will be on a lot to lot
***3** basis. A standard lot for all requirements will be equal to **300** tons.
Acceptance of hot-mix asphalt will be made based on in-place density, ***3**
laboratory air voids, grade and smoothness in accordance with the following paragraphs. Grade and surface smoothness determinations will be made on the lot as a whole. Exceptions or adjustments to this will be made in situations where the mix within one lot is placed as part of both the intermediate and surface courses, thus grade and smoothness measurements for the entire lot cannot be made. In order to evaluate laboratory air voids and in-place (field) density, each lot will be divided into four equal sublots.

***3** 3.11.1 **NOT USED** ***3**

3.11.2 Sublot Sampling

One random mixture sample for determining laboratory air voids, theoretical maximum density, and for any additional testing the Contracting Officer desires, will be taken from a loaded truck delivering mixture to each sublot, or other appropriate location for each sublot. All samples will be selected randomly, using commonly recognized methods of assuring randomness conforming to ASTM D 3665 and employing tables of random numbers or computer programs. Laboratory air voids will be determined from three laboratory compacted specimens of each sublot sample in accordance with ASTM D 1559. The specimens will be compacted within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Samples will not be reheated prior to compaction and insulated containers will be used as necessary to maintain the temperature.

3.11.3 Additional Sampling and Testing

The Contracting Officer reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. The cost of any additional testing will be paid for by the Government. Testing in these areas will be in addition to the lot testing, and the requirements for these areas will be the same as those for a lot.

3.11.4 Laboratory Air Voids

Laboratory air voids will be calculated by determining the Marshall density of each lab compacted specimen using ASTM D 2726 and determining the theoretical maximum density of every other sublot sample using ASTM D 2041. Laboratory air void calculations for each sublot will use the latest theoretical maximum density values obtained, either for that sublot or the previous sublot. The mean absolute deviation of the four laboratory air void contents (one from each sublot) from the JMF air void content will be evaluated and a pay factor determined from Table 5. All laboratory air void tests will be completed and reported within 24 hours after completion of construction of each lot.

3.11.5 Mean Absolute Deviation

An example of the computation of mean absolute deviation for laboratory air voids is as follows: Assume that the laboratory air voids are determined from 4 random samples of a lot (where 3 specimens were compacted from each sample). The average laboratory air voids for each sublot sample are determined to be 3.5, 3.0, 4.0, and 3.7. Assume that the target air voids from the JMF is 4.0. The mean absolute deviation is then:

Mean Absolute Deviation = $(|3.5 - 4.0| + |3.0 - 4.0| + |4.0 - 4.0| + |3.7 - 4.0|/4$

$= (0.5 + 1.0 + 0.0 + 0.3)/4 = (1.8)/4 = 0.45$

The mean absolute deviation for laboratory air voids is determined to be 0.45. It can be seen from Table 5 that the lot's pay factor based on laboratory air voids, is 100 percent.

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Table 5. Pay Factor Based on Laboratory Air Voids

Mean Absolute Deviation of Lab Air Voids from JMF	Pay Factor, %
0 - 1.20	**Accept (100%)**
Above 1.20	reject (0)

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3.11.6 In-place Density

3.11.6.1 General Density Requirements

For determining in-place density, one random core will be taken by the Government from the mat (interior of the lane) of each sublot, and one random core will be taken from the joint (immediately over joint) of each sublot. Each random core will be full thickness of the layer being placed. When the random core is less than 1 inch thick, it will not be included in the analysis. In this case, another random core will be taken. After air drying to a constant weight, cores obtained from the mat and from the joints will be used for in-place density determination.

3.11.6.2 Mat and Joint Densities

The average in-place mat and joint densities are expressed as a percentage of the average Marshall density for the lot. The Marshall density for each lot will be determined as the average Marshall density of the four random samples (3 specimens compacted per sample). The average in-place mat density and joint density for a lot are determined and compared with ***3** Table 6 to **determine acceptability** per lot based on in-place density. All density results for a lot will be completed and reported within 24 hours after the construction of that lot. **When the specified density is not obtained, the Contractor may elect to take additional cores to define the limits of low densities and shall correct each area by removing the pavement and replacing with new pavement meeting project requirements. In replacement of the pavement in question, the removal shall be continuous without skips for isolated passing areas until all remaining pavements are continuous and meet the required densities. Removals of pavement shall be for the full width of a paving lane. The Contractor shall fill all sample holes with hot-mix, compact and finish.**

Table 6. Pay Factor Based on In-place Density

Average Mat Density (4 Cores)	Pay Factor, %	Average Joint Density (4 Cores)
96.0 **to** 101.0	**Accept**	94.5 **or above**
below 96.0 or above 101.0	**Reject**	below 94.5

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3.11.7 Grade

The final wearing surface of pavement shall conform to the elevations and cross sections shown and shall vary not more than 0.05 foot from the plan grade established and approved at site of work. Finished surfaces at juncture with other pavements shall coincide with finished surfaces of abutting pavements. Deviation from the plan elevation will not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved. The final wearing surface of the pavement will be tested for conformance with specified plan grade requirements. The grade will be determined by running lines of levels at intervals of 25 feet, or less, longitudinally and transversely, to determine the elevation of the completed pavement surface. Within 5 working days, after the completion of a particular lot incorporating the final wearing surface, the Contracting Officer will inform the Contractor in writing, of the results of the grade-conformance tests. When more than 5 percent of all measurements made within a lot are outside the 0.05 foot tolerance, the pay factor based on grade for that lot will be 95 percent. In areas where the grade exceeds the tolerance by more than 50 percent, the Contractor shall remove the surface lift full depth; the Contractor shall then replace the lift with hot-mix asphalt to meet specification requirements, at no additional cost to the Government.

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Skin patching for correcting low areas or planing or milling for correcting high areas will not be permitted.

3.11.8 Surface Smoothness

The Contractor shall use both of the following methods to test and evaluate surface smoothness of the pavement. All testing shall be performed in the presence of the Contracting Officer. Detailed notes of the results of the testing shall be kept and a copy furnished to the Government immediately after each day's testing. The profilograph method shall be used for all longitudinal and transverse testing, except where the runs would be less than 200 feet in length and the ends where the straightedge shall be used. Where drawings show required deviations from a plane surface (crowns, drainage inlets, etc.), the surface shall be finished to meet the approval of the Contracting Officer.

3.11.8.1 Smoothness Requirements

a. Straightedge Testing: The finished surfaces of the pavements shall have no abrupt change of 1/4 inch or more, and all pavements shall be within the tolerances specified in Table 7 when checked with an approved 12 foot straightedge.

Table 7. Straightedge Surface Smoothness--Pavements

Pavement Category	Direction of Testing	Tolerance, inches
All paved areas	Longitudinal	1/4
	Transverse	1/4

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3.11.8.2 Testing Method

After the final rolling, but not later than 24 hours after placement, the surface of the pavement in each entire lot shall be tested by the Contractor in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. Separate testing of individual
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sublots is not required. The entire area of the pavement shall be tested in both a longitudinal and a transverse direction on parallel lines. The transverse lines shall be 25 feet or less apart, as directed. The longitudinal lines shall be at the centerline of each paving lane for lines less than 20 feet and at the third points for lanes 20 feet or greater. Other areas having obvious deviations shall also be tested. Longitudinal testing lines shall be continuous across all joints.

a. Straightedge Testing. The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points.
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***3**
3.11.8.3 **Not Used** ***3**
***3**
3.11.8.4 Pavement Correction for Smoothness

Areas which are found to deviate more than the defined tolerances listed above shall be corrected. The Contractor shall remove the deficient area and replace with fresh paving mixture at no additional cost to the Government. Sufficient material shall be removed to allow at least 1 inch of asphalt concrete of similar mix removed to be placed. The following will not be permitted: (1) skin patching for correcting low areas, (2) planing or milling for correcting high areas.
***3**

-- End of Section --

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DIVISION 03 - CONCRETE

SECTION 03151

EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS IN CONCRETE FOR CIVIL WORKS

04/93

-- End of Section Table of Contents --

SECTION 03151

EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS IN CONCRETE FOR CIVIL WORKS
04/93

PART 1 GENERAL

1.1 Scope

This specification covers expansion, contraction, construction joints, and waterstops for civil works projects. Included are the requirements for materials, workmanship, and dimensions.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 920	(1995) Elastomeric Joint Sealants
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

***3**

ASTM D 3542	**(1998) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Bridges**

***3**

CORPS OF ENGINEERS (COE)

COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop

1.3 DEFINITIONS

1.3.1 Expansion Joint

An "Expansion Joint" is hereafter defined as shown on Sheet C-42 of the contract drawings, and applies only to concrete pavements/hardstands.

1.3.2 Contraction Joint

A "Contraction Joint" is hereafter defined as shown on Sheet C-42 of the contract drawings, and applies only to concrete pavements/hardstands.

1.3.3 Conventional Concrete Monolith Joint

A "Conventional Concrete Monolith Joint" is hereafter defined as the joint between conventional concrete monoliths, and the joint between roller compacted concrete and conventional concrete monoliths in the lock structure shown on sheet S-15 of the contract drawings.

1.3.4 Roller Compacted Concrete Contraction Joint

A "Roller Compacted Concrete Monolith Joint" is hereafter defined as the joint between roller compacted concrete monoliths as shown on sheet S-209 of the contract drawings.

1.3.5 Construction Joint

A "Construction Joint" is hereafter defined as shown on Sheet C-42 of the contract drawings, and applies only to concrete pavements/hardstands. Construction joints as shown on the concrete monolith drawings in the lock structure are not included in this specification.

1.3.6 Waterstops

A "Waterstop" is hereafter defined as a diaphragm placed across a Monolith Joint in the Lock Structure to prevent the passage of water.

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1.3.7 **Monolith Compression Seals**

A "Monolith Compression Seal" is hereafter defined as shown on Sheet S-14A of the contract drawings.

***3**

1.4 PAYMENT

1.4.1 Waterstops

1.4.1.1 Payment

Payment will be made for costs associated with waterstops, including labor, materials and use of all equipments and tools required to complete the waterstop work. These costs shall be included in the contract lump sum price for "Waterstops" listed in the bidding schedule. No separate payment will be made for expansion and contraction joints which are included in the costs for the items to which work for expansion and contraction joints are incidental.

1.4.2 Expansion, Contraction, and Construction Joints

1.4.2.1 Payment

No separate payment will be made for expansions and contraction joints which are included in the costs for the items to which work for expansion and contraction joints are incidental.

1.5 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-08 Statements

Splicing Waterstops; GA,RE.

Procedures for splicing waterstops shall be submitted.

SD-09 Reports

Premolded Expansion Joint Filler Strips; GA, ED

SD-14 Samples

Field Molded Sealants and Primer; GA, ED

One gallon of field-molded sealant and one quart of primer (when primer is recommended by the sealant manufacturer) shall be provided for testing.

Waterstops; GA, ED

Waterstop materials and splice samples shall be submitted for inspection and testing and shall be identified to indicate manufacturer, type of material, size and quantity of material and shipment represented. Each materials sample shall be a piece not less than 12 inches long cut from each 200 feet of finished waterstop furnished, but not less than a total of four linear feet of each type and size furnished. For spliced segments of waterstops to be installed in the work, one spliced sample of each size and type for every 50 splices made in the factory and every 10 splices made at the job site shall be furnished for inspection and testing. The spliced samples shall be made using straight run pieces with the splice located at the mid-length of the sample and finished as required for the installed waterstop. The total length of each spliced sample shall be not less than 12 inches long.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Premolded Expansion Joint Filler Strips

Premolded expansion joint filler strips for pavement shall conform to ASTM D 1751 or ASTM D 1752, Type I, or resin impregnated fiberboard conforming to the physical requirements of ASTM D 1752.
Premolded expansion joint filler strips for Conventional Concrete Monolith Joints shall conform to ASTM D 1752, Type I. Expansion joint material placed between the new South wall monoliths and the existing 600 ft. South wall monoliths shall conform to ASTM D 1752, Type I.

2.1.2 Joint Seals and Sealants

2.1.2.1 Field Molded Sealants and Primer

Field molded sealants and primer shall conform to ASTM C 920, Type S, Grade NS, Class 25, use NT for vertical joints and Type S, Grade P, Class 25, use T for horizontal joints. Bond breaker material shall be polyethylene tape, coated paper, metal foil or similar type materials. The back-up material shall be compressible, nonshrink, nonreactive with sealant, and nonabsorptive material type such as extruded butyl or polychloroprene foam rubber.

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2.1.2.2 Compression Seals and Lubricant

Compression seals and Lubricant shall comply with Section 02762 COMPRESSION JOINT SEALS FOR CONCRETE PAVEMENTS. Monolith Compression Seals shall comply with testing and submittal requirements of Section 02762 COMPRESSION JOINT SEALS FOR CONCRETE PAVEMENTS. Monolith compression joint seal materials shall be a vulcanized elastomeric compound using polychloroprene as the only base polymer. The material and manufactured seal shall conform to ASTM D 3542. The joint seal shall be a labyrinth type seal.

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2.1.3 Waterstops

2.1.3.1 Non-Metallic Waterstops

Polyvinylchloride waterstops shall conform to COE CRD-C 572.

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2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Materials Tests

2.2.1.1 Field-Molded Sealants

Samples of sealant and primer, when use of primer is recommended by the manufacturer, as required in paragraph FIELD MOLDED SEALANTS AND PRIMER, shall be tested by and at the expense of the Government for compliance with paragraph FIELD MOLDED SEALANTS AND PRIMER. If the sample fails to meet specification requirements, new samples shall be provided and the cost of retesting will be deducted from payments due the Contractor.

2.2.1.2 Non-Metallic Waterstops

Samples of materials and splices as required in paragraph WATERSTOPS shall be visually inspected and tested by and at the expense of the Government for compliance with COE CRD-C 572 as applicable. The tests shall be performed at the U.S. Army Corps of Engineers, Engineer Research and Development Center in Vicksburg, Mississippi. If a sample fails to meet the specification requirements, new samples shall be provided and the cost of retesting will be deducted from payments due the Contractor at the rate of $195 per material sample retested and $1040 per spliced sample retested.

2.2.2 Splicing Waterstops

2.2.2.1 Procedure and Performance Qualifications

Procedure and performance qualifications for splicing waterstops shall be demonstrated in the presence of the Contracting Officer.

2.2.2.2 Non-Metallic Waterstops

Procedure and performance qualifications for splicing non-metallic waterstops shall be demonstrated by the manufacturer at the factory and the Contractor at the job site by each making three spliced samples of each size and type of finished waterstop.

2.2.2.3 NOT USED - Metal Waterstops

PART 3 EXECUTION

3.1 INSTALLATION

Joint locations and details, including materials and methods of installation of joint fillers and waterstops, shall be as specified, as shown, and as directed. In no case shall any fixed metal be continuous through an expansion or contraction joint.

3.1.1 Expansion Joints

Premolded filler strips shall have oiled wood strips secured to the top thereof and shall be accurately positioned and secured against displacement to clean, smooth concrete surfaces. The wood strips shall be slightly tapered, dressed and of the size required to install filler strips at the desired level below the finished concrete surface and to form the groove for the joint sealant or seals to the size shown. Material used to secure premolded fillers and wood strips to concrete shall not harm the concrete and shall be compatible with the joint sealant or seals. The wood strips shall not be removed until after the concrete curing period. The groove shall be thoroughly cleaned of all laitance, curing compound, foreign materials, protrusions of hardened concrete and any dust which shall be blown out of the groove with oil-free compressed air.

3.1.1.1 Joints With Field-Molded Sealant

Joints shall not be sealed when the sealant, air or concrete temperature is less than 40 degrees F. Immediately prior to installation of field molded sealants, the joint shall be cleaned of all debris and further cleaned using water, chemical solvents or other means as recommended by the sealant manufacturer. The joints shall be dry prior to filling with sealant. Bond breaker and back-up material shall be installed where required. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations.

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3.1.1.2 Joints With Preformed Compression Seals

The joint seals **for pavement** shall be installed in correspondence with the procedure in Specifications Section 02762.

***3**

3.1.2 Contraction Joints

Sawcuts for contraction joints shall be thoroughly cleaned before the installation of preformed compression seal in correspondance with the procedure in specifications section 02762.

3.1.3 Conventional Concrete Monolith Joints

All Monolith Joints shall be covered by 1-inch thick pre-molded joint filler. Waterstops shall be protected during application of bond breaking material to prevent them from being coated. Surfaces to which pre-molded joint filler is to be applied shall be clean and dry. Pre-molded joint filler shall be applied at least 24 hours prior to placement of adjacent concrete.

3.1.4 Roller Compacted Concrete Monolith Joints

Installation of the Roller Compacted Concrete contraction joints shall proceed as shown on sheet S-208 of the contract drawings.

***3**

3.1.5 Monolith Compression Seals

The joint seals shall be installed with equipment which shall be capable of installing joint seals to the prescribed depth without cutting, nicking, twisting, or otherwise distorting or damaging the seal and with no more than five percent stretching of the seal. The sides of the joint and, if necessary, the sides of the compression seal shall be covered with a coating of lubricant, and the seal shall be installed to the depth indicated with joint installation equipment. Butt joints shall be coated with liberal applications of lubricant. Joint seals shall be installed 1/4 inch, plus or minus 1/8 inch below the concrete surface.

3.1.5.1 Preparation of Joints

Immediately before installation of the compression joint seal, the joints shall be thoroughly cleaned to remove laitance, filler, existing sealer, foreign material and protrusions of hardened concrete from the sides and upper edges of the joint space to be sealed. Cleaning shall be by sandblasting or waterblasting and shall extend along pavement surfaces at least 1/2 inch on either side of the joint. Waterblasting shall conform to requirements in Section 02762. After final cleaning and immediately prior to sealing, the joints shall be blown out with compressed air and left completely free of debris and water. The Contractor shall demonstrate that the selected cleaning operation meets the cleanliness requirements. Any irregularity in the joint face which would prevent uniform contact between the joint seal and the joint face shall be corrected prior to the installation of the joint seal.

3.1.5.2 Rate of Progress

Sandblasting or waterblasint of joint faces shall be limited to the length of joint that can be sealed during the same workday.

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3.1.6 Waterstops

Waterstops shall be carefully and correctly positioned during installation to eliminate faulty installation that may result in joint leakage. The bottom of each waterstop shall be embedded a minimum of 24 inches in firm rock or sealed to other cut-off systems. All waterstops shall be installed so as to form a continuous watertight diaphragm in each joint. Adequate provision shall be made to support and protect the waterstops during the progress of work. Any waterstop punctured or damaged shall be replaced or repaired at the Contractor's expense. The concrete shall be thoroughly consolidated in the vicinity of the waterstop. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued.

3.1.6.1 Splices

Joints in waterstops shall be spliced together by qualified splicers using the approved splicing procedures to form a continuous watertight diaphragm. Splices shall be as followed:

a. Non-Metallic Waterstops - All splices shall be made on a bench in a temporary shop provided at the site of the installation or at the manufacturer's plant. A miter guide and portable power saw shall be used to cut the ends to be joined to insure good alignment and contact between joined surfaces. Continuity of the characteristic features of the cross section of the waterstop (ribs, tabular center axis, protrusions and the like) shall be maintained across the splice.

b. Polyvinylchloride Waterstops - Splices shall be made by heat sealing the adjacent surfaces in accordance with the approved procedure. A thermostatically controlled electrical heat source shall be used to make all splices. The correct temperature at which splices should be made will differ with the material concerned but the applied heat should be sufficient to melt but not char the plastic. Waterstops shall be reformed at splices with a remolding iron with ribs or corrugations to match the pattern of the waterstop. The spliced area, when cooled and bent by hand in as sharp an angle as possible, shall show no sign of separation.

-- End of Section --

TABLE 1 - CONCRETE MIXTURE PROPORTIONING CRITERIA											
Mix No.	Application	Proportion-ing Respons-ibility	Minimum Specified Strength (psi)	Age at Specified Strength (days)	Maximum Water/ Cement + Pozzolan	Approximate Cement Content (lbs/yd^3)	Minimum Pozzolan Content (%)	Pozzolan Class	Required Slump (inches)	Required Air Content (%)	Aggregate Size ASTM C 33 Designation
Mass Concrete											
1	Exterior and RCC Facing Concrete	Gov't	3500	90	0.45	200-300	35	F Only	2-4	3.5-6.5	#3 & #57
2	Interior	Gov't	2500	90	0.60	150-250	35	F Only	2-4	3.5-6.5	#3 & #57
Roller Compacted Concrete											
3	RCC	Gov't	2500	90	0.60	130-200	50	F Only	N/A	N/A	#3 & #57
4	Bedding/ Dental Mortar	Gov't	3000	28	0.45	400-550	25	C or F	8-10	6.0-9.0	ASTM C33 Concrete Sand
Foundation Concrete											
5	Dental Concrete	Contractor	4000	28	0.45	400-550	20	C or F	2-4	4.5-7.5	#57
Emptying and Filling System											
6	Lock Floor Culverts, Baffles, Port Extensions and Diffusers	Gov't	4000	90	0.45	400-550	25	C or F	2-4	4.5-7.5	#57

TABLE 1 - CONCRETE MIXTURE PROPORTIONING CRITERIA

Mix No.	Application	Proportioning Respons-ibility	Minimum Specified Strength (psi)	Age at Specified Strength (days)	Maximum Water/ Cement + Pozzolan	Approximate Cement Content (lbs/yd^3)	Minimum Pozzolan Content (%)	Pozzolan Class	Required Slump (inches)	Required Air Content (%)	Aggregate Size: ASTM C 33 Designation
*3 Access Bridge **and Overlook Structure**											
7	Drilled Shafts	Gov't	5000	90	0.40	450-600	25	C or F	8-10*	4.5-7.5	#67
5	Piers/ Abutments	Contractor	4000	28	0.45	400-550	20	C or F	4-6	4.5-7.5	#57
8	Precast Beams	Contractor	7000	28	0.35	500-650	20	C or F	2-5	4.5-7.5	#57
9	Bridge Deck Pavement & **Overlook Deck**	Contractor	4500	28	0.45	400-550	20	C or F	2-5	4.5-7.5	#57 *3
Approach Wall Concrete											
7	Drilled Shafts	Gov't	5000	90	0.40	450-600	25	C or F	8-10*	4.5-7.5	#67
10	Precast Beams and Butresses	Contractor	5000	28	0.40	450-600	20	C or F	2-5	4.5-7.5	#57
11	End Cells & Intermediate Cells	Gov't	4000	90	0.45	400-550	35	C or F	8-10*	4.5-7.5	#57
Miscellaneous Concrete											
5	Trench Slab Covers	Contractor	4000	28	0.45	400-550	20	C or F	2-4	4.5-7.5	#57
12	Precast Drainage Culverts	Contractor	3500	28	0.45	350-500	20	C or F	2-4	4.5-7.5	#57
12	Esplanade Slab Concrete	Contractor	3500	28	0.45	350-500	20	C or F	2-4	4.5-7.5	#57

* The drilled shaft and end cell concrete shall also have a slump flow of 16” to 20”. Both slump and slump flow requirements shall be met.

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DIVISION 03 - CONCRETE

SECTION 03301

CAST-IN-PLACE STRUCTURAL CONCRETE

-- End of Section Table of Contents --

SECTION 03301

CAST-IN-PLACE STRUCTURAL CONCRETE

PART 1 GENERAL

***3**

This specification covers concrete for use in slabs, the bridge piers and deck, the approach wall piers, the foundation drilled shafts for the bridge piers and the approach walls, **overlook structure**, emptying and filling culverts, concrete cutoff wall, and any other structural or miscellaneous (headwalls, sidewalks, etc.) concrete for the project.

***3**

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 117/117R	(1990; Errata) Standard Tolerances for Concrete Construction and Materials
ACI 305R	(1991) Hot Weather Concreting
ACI 306R	(1991) Cold Weather Concreting

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 94	(2000) Ready-Mixed Concrete
ASTM C 171	(1997a) Sheet Materials for Curing Concrete
ASTM C 309	(1998) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 1064	(1999) Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1107	(1998) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

CORPS OF ENGINEERS (COE)

COE CRD-C 94	(1995) Specifications for Surface Retarders

COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete

1.2 UNIT PRICES

1.2.1 Payment

***3**

Payment will be made for costs associated with completing the work for concrete placed as cast-in-place structural concrete as described herein. This shall include the bridge piers and deck, approach wall piers, **emptying and filling system,** foundation drilled shafts for the bridge and approach walls, cutoff walls, esplanade slabs and all other cast-in-place **miscellaneous** concrete for the project not specified elsewhere. However, these costs will not include the cost of cement, pozzolan, reinforcement, admixtures, and embedded parts that are specified to be paid for separately. No payment will be made for concrete, as such, that is placed in structures of which payment is made as a lump sum.

***3**

1.2.2 Measurement

Concrete will be measurement for payment based upon the actual volume of concrete within the pay lines of the structures as indicated on the drawings. Measurement of concrete placed against the sides of any excavation without the use of intervening forms shall be made only within the pay lines of the structure. No deductions shall be made for rounded or beveled edges, space occupied by metal work, electrical conduits or reinforcing steel, or for voids or embedded items that are either less than 5 cubic feet in volume or 1 square foot in cross section.

1.2.3 Unit of Measure

Unit of measure: cubic yards.

1.3 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES.

SD-01 Data

Placing Equipment and Methods; GA,RE.

All placing equipment and methods shall be submitted for review by the Contracting Officer at least 60 days prior to the start of concrete placement for conformance with paragraph CAPACITY.

End Cell Unwatering and Bracing; GA,RE.

The proposed methods for unwatering the end cells and for providing internal bracing shall be submitted for review by the Contracting Officer for conformance with the paragraph CONCRETE IN END CELLS.

SD-08 Statements

Construction Joint Treatment; GA,RE.

The method and equipment proposed for joint cleanup and waste disposal shall be submitted for review and approval for conformance with paragraph CONSTRUCTION JOINT TREATMENT. This shall be submitted at least 30 days prior to the start of concrete placement.

Concreting Plan; GA,RE.

A plan shall be submitted for approval at least 90 days prior to the start of placement for all concrete covered by this specification. The plan shall show and describe the equipment and methods proposed and shall include, but not be limited to the following:

1) Preparation of foundation and formwork.
2) Batching, including the timing of the introduction of the concrete materials and temperature control.
3) Mixing, including speed and duration.
4) Transportation and conveyance from the mixer to the point of placement.
5) Sampling and testing of concrete.
6) Placing equipment and methods.
7) Procedures for interrupted concrete placement.
8) Consolidation of concrete.
9) Finishing of concrete.
10) Curing and protection of concrete.

The timing and sequence of the various steps shall also be described. The plan shall be of sufficent detail to demonstrate that equipment and methods are appropriate for the specific type of concrete, and that the work conforms to all requirements specified herein. A separate plan shall be submitted for each of the following concretes: drilled shafts and end cells, bridge piers, emptying/filling culverts, slabs and pavements. Once approved, the Contractor shall follow all procedures outlined in the plan. Any revisions to the plan shall be submitted to the Contracting Officer for approval.

SD-13 Certificates

Impervious-Sheet Curing Materials; FIO.

Impervious-Sheet Curing Materials shall be certified for compliance with all specification requirements.

Membrane-Forming Curing Compound; GA,RE.

Membrane-Forming Curing Compound shall be certified for compliance with all specification requirements.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials shall be as specified in Section 03300 General Concrete Requirements.

2.1.2 Aggregates

Concrete aggregates shall be as specified in Section 03300 General Concrete Requirements.

2.1.3 Chemical Admixtures

Chemical admixtures shall be as specified in Section 03300 General Concrete Requirements.

2.1.4 Curing Materials

Curing materials shall be as specified in Section 03300 General Concrete Requirements.

2.1.5 Water

Water for mixing and curing shall be as specified in Section 03300 General Concrete Requirements.

2.2 CONCRETE MIXTURE PROPORTIONING

Concrete mixture proportioning shall be as specified in Section 03300 General Concrete Requirements.

PART 3 EXECUTION

3.1 EQUIPMENT

3.1.1 Batch Plant

Batch plant shall conform to the requirements of Section 03300 General Concrete Requirements.

3.1.2 Conveying Equipment

The conveying equipment shall conform to the following requirements.

3.1.2.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least five times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 2 square feet. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 2 cubic yards shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

3.1.2.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles and have conical-shaped discharge features. The transfer hopper shall be equipped with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Concrete shall not be held in nonagitating transfer hoppers more than 30 minutes.

3.1.2.3 Truck Mixers

Truck mixers shall only be allowed for production and placement of Miscellaneous Concrete. They will not be allowed for production of Mass Concrete, RCC or bedding mortar, dental concrete or mortar, nor any concrete produced for the approach walls or the fixed bridge.
Truck mixers and the mixing of concrete therein shall conform to the requirements of ASTM C 94. A truck mixer may only be used to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall be equipped with two counters from which it shall be possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed. Truck mixers shall not be used to mix or agitate concrete with greater than 1-1/2 inch nominal maximum-size aggregate or concrete with a slump of 2 inches or less. The acceptability of truck mixers shall be determined by uniformity tests in accordance with ASTM C 94.

3.1.2.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes attached to this equipment by the manufacturer may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

3.1.2.5 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete at the transfer points and the point of placing. Belt conveyors shall be constructed such that the idler spacing shall not exceed 36 inches. The belt speed shall be a minimum of 300 feet per minute and a maximum of 750 feet per minute. Belt width shall be a minimum of 16 inches. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the conveyor shall discharge concrete into a pipe or elephant trunk that is long enough to extend through the reinforcing bars.

3.1.2.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least three times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 4 inches. Aluminum pipe shall not be used.

3.1.3 Vibrators

Vibrators of the proper size, frequency, and amplitude shall be used for the type of work being performed in conformance with the following requirements:

APPLICATION	HEAD DIAMETER INCHES	FREQUENCY VPM	AMPLITUDE INCHES
Thin walls, beams, etc.	1-1/4 to 2-1/2	9,000 to 13,500	0.02 to 0.04
General construction	2 to 3-1/2	8,000 to 12,000	0.025 to 0.05

The frequency and amplitude shall be determined in accordance with COE CRD-C 521.

3.2 PREPARATION FOR PLACING

3.2.1 Embedded Items

Before placement of concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required by ACI 117/117R. Embedded items shall be free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids. Welding, including tack welding, will not be permitted on embedded metals within 2 feet of the surface of the concrete.

3.2.2 Concrete on Earth Foundations

Earth surfaces upon which concrete is to be placed shall be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, the earth foundation shall have been satisfactorily compacted in accordance with Section 02300 Earthwork.

3.2.3 Construction Joint Treatment

Construction joint treatment shall conform to the following requirements.

3.2.3.1 Joint Preparation

Concrete surfaces to which additional concrete is to be bonded shall be prepared for receiving the next lift or adjacent concrete by cleaning with either air-water cutting, sandblasting, high-pressure water jet, or other approved method. Air-water cutting will not be permitted on formed surfaces or surfaces congested with reinforcing steel. Regardless of the method used, the resulting surfaces shall be free from all laitance and inferior concrete so that clean, well bonded coarse aggregate is exposed uniformly throughout the lift surface. The edges of the coarse aggregate shall not be undercut. The surface shall be washed clean again as the last operation prior to placing the next lift. There shall be no standing water on the surface upon which concrete is placed.

3.2.3.2 Air-Water Cutting

Air-water cutting of a construction joint shall be performed at the proper time and only on horizontal construction joints. The air pressure used in the jet shall be 90 to 110 psi, and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. When approved by the Contracting Officer, a retarder complying with the requirements of COE CRD-C 94 may be applied to the surface of the lift to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, the Contractor shall furnish samples of the material to be used and shall demonstrate the method to be used in applications. After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, high-pressure water jet or sandblasting will be required as the last operation before placing the next lift.

3.2.3.3 High-Pressure Water Jet

A stream of water under a pressure of not less than 3,000 psi may be used for cleaning. Its use shall be delayed until the concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse-aggregate particles. If the water jet is incapable of a satisfactory cleaning, the surface shall be cleaned by sandblasting.

3.2.3.4 Wet Sandblasting

This method may be used when the concrete has reached sufficient strength to prevent undercutting of the coarse aggregate particles. The surface of the concrete shall then be washed thoroughly to remove all loose materials.

3.2.3.5 Waste Disposal

The method used in disposing of waste water employed in cutting, washing, and rinsing of concrete surfaces shall be such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal shall be addressed in the Contractor's Solid and Hazardous Waste Management Plan, as required by Section 01410 ENVIRONMENT PROTECTION.

3.2.4 Concrete in End Cells

3.2.4.1 Tremie Concrete

Prior to placing concrete in the end cells, the backfill materials in the cells shall be removed. The materials shall be excavated by the air lift process or other means that will achieve the desired results. Excavated materials shall be disposed of in conformance with Section 01410 Environmental Protection. The surface shall be inspected immediately prior to the beginning of tremie concrete placement operations to determine the amount of silt and clay on the rock surface. The amount of sand, gravel, and cobbles is not of concern; however, if more than one inch of silt and clay is present over more than 50% of the area, it shall again be cleaned by the airlift method to remove the remaining soil.

3.2.4.2 Cast-In-Place Concrete

The cast-in-place concrete shall be placed in the dry. The Contractor shall provide an unwatering system to permit construction of the formwork and other operations within the end cells. In the event there is a differential head in excess of 5 feet between the top of the tremie concrete and the river stage, the Contractor shall install temporary bracing to maintain the shape and alignment of the cell. No cast-in-place concrete shall be placed in standing water.

3.3 PLACING

3.3.1 Placing Procedures

The surfaces of horizontal construction joints shall be kept continuously wet for the first 24 hours during the 48-hour period prior to placing concrete and then allowed to air dry. Concrete placement will not be permitted when, in the opinion of the Contracting Officer, weather conditions prevent proper placement and consolidation. Concrete shall be deposited as close as possible to its final position in the forms and, in so depositing, there shall be no vertical drop greater than 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it may be effectively consolidated in horizontal layers 18 inches or less in thickness with a minimum of lateral movement. The amount deposited in each location shall be that which can be readily and thoroughly consolidated. Sufficient placing capacity shall be provided so that concrete placement can be kept plastic and free of cold joints while concrete is being placed. Concrete shall be placed by methods that will prevent segregation or loss of ingredients. Any concrete transferred from one conveying device to another shall be passed through a hopper that is conical in shape. The concrete shall not be dropped vertically more than 5 feet, except where a properly designed and sized elephant trunk with rigid drop chute bottom section is provided to prevent segregation and where specifically authorized. In no case will concrete be discharged to free-fall through reinforcing bars.

3.3.2 Placement by Pump

When concrete is to be placed by pump, the nominal maximum-size coarse aggregate shall not be reduced to accommodate the pumps. The distance to be pumped shall not exceed limits recommended by the pump manufacturer. The concrete shall be supplied to the concrete pump continuously. When pumping is completed, concrete remaining in the pipeline shall be ejected without contamination of concrete in place. After each operation, equipment shall be thoroughly cleaned, flushing water shall be wasted outside of the forms, and any cleanup of equipment shall be in accordance with section 01410 ENVIRONMENT PROTECTION. Grout used to lubricate the pumping equipment at the beginning of the placement will not be incorporated into the placement.

3.3.3 Time Interval Between Mixing and Placing

Concrete shall be placed within 30 minutes after discharge into nonagitating equipment. Concrete shall be delivered to the site of the work, and discharge shall be completed within 1-1/2 hours after introduction of the cement to the aggregates.

3.3.4 Cold-Weather Placing

When cold-weather placing of concrete is likely to be subjected to freezing temperatures before the expiration of the curing period, it shall be placed in accordance with procedures previously submitted in accordance with paragraph SUBMITTALS and in accordance with ACI 306R Cold Weather Concreting. The ambient temperature of the space adjacent to the concrete placement and surfaces to receive concrete shall be above 32 degrees F. The placing temperature of the concrete having a minimum dimension less than 12 inches shall be between 55 and 75 degrees F when measured in accordance with ASTM C 1064. The placing temperature of the concrete having a minimum dimension greater than 12 inches shall be between 50 and 70 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete-placing temperatures. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals, or other materials shall not be mixed with the concrete to prevent freezing.

3.3.5 Hot-Weather Placing

Concrete shall be properly placed and finished with procedures previously submitted in accordance with paragraph SUBMITTALS and in accordance with ACI 305R Hot Weather Concreting. The concrete-placing temperature shall not exceed 90 degrees F when measured in accordance with ASTM C 1064. Cooling of the mixing water and aggregates, or both, may be required to obtain an adequate placing temperature. A retarder meeting the requirements of paragraph WATER-REDUCING OR RETARDING ADMIXTURES may be used to facilitate placing and finishing. Steel forms and reinforcement shall be cooled prior to concrete placement when steel temperatures are greater than 120 degrees F. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature.

3.3.6 Consolidation

Immediately after placement, each layer of concrete shall be consolidated by internal vibrating equipment. Vibrators shall not be used to transport concrete within the forms. Hand spading may be required, if necessary, with internal vibrating along formed surfaces permanently exposed to view. Form or surface vibrators shall not be used unless specifically approved. The vibrator shall be inserted vertically at uniform spacing over the entire area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding unhardened layer if such exists. It shall be held stationary until the concrete is consolidated and then withdrawn slowly. Concrete placed in the utility trenches shall be consolidated by internal vibration.

3.3.7 Concrete for Drilled Shafts/Piers, End Cells, and Any Other Underwater Concrete

Concrete for the bridge drilled shafts, approach wall shafts/piers and end cells and any other concrete placed underwater shall be deposited by gravity through a tremie pipe. Concrete pumps will not be permitted for underwater placement of concrete except to deliver concrete to the tremie. Concrete buckets will not be permitted for underwater placement of concrete except to deliver concrete to the tremie. The methods and equipment used shall be submitted for approval in the Concrete Plan.

3.3.7.1 Concrete Placement

Concrete placed in permanent casing, in the end cells, or any underwater concrete shall conform to the procedures described herein. Concrete shall be continuously placed by methods that insure against segregation and shall completely fill the appropriate structure in one continuous placement. Concrete placement will not be permitted when, in the opinion of the Contracting Officer, weather or river conditions prevent proper placement and consolidation of the concrete.

Tremie concrete shall be placed by the "dry pipe" technique. The tremie shall be watertight and sufficiently large to permit a free flow of concrete. The tremie pipe shall have a minimum diameter of ten inches and incorporate a hopper of two cubic yards minimum capacity. At the start of the tremie placement, the bottom of the tremie pipe shall be sealed with a sliding or hinged plate and gasket, or a sacrificial plate and gasket. "Rabbits, pigs or go-devils" will not be permitted for sealing the tremie pipe. The pipe shall be kept dry with a sealed plate as it is lowered into the structure. The tremie pipe shall be extended and shall rest on the bottom of the structure while the tremie pipe and hopper are charged with concrete. Once charged, the tremie pipe shall be raised six inches off the bottom of the structure, and the sealed plate shall be released to initiate placement of the concrete. The pipe shall be held near the bottom of the structure until a minimum five-foot head of concrete builds around the pipe. At least five to ten feet of concrete shall be allowed to build around the pipe before it is lifted. Once lifting begins, the discharge end of the tremie pipe shall be kept continuously submerged in the concrete a minimum of five feet. A sufficient head of concrete shall be maintained within the tremie pipe to sustain a positive differential head relative to the surrounding concrete and water column in the structure. The tremie pipe shall not be moved horizontally during a placing operation, and a sufficient number of tremies shall be provided so that the maximum horizontal flow will be limited to 15 feet. Placement shall proceed without interruption until the concrete has been brought to the required height.

The Contractor shall continuously measure and record the level of concrete within the structure. A placement log shall be maintained by the contractor for any concrete that is deposited underwater. The log shall show the placement location, tip elevation of pile/shaft, quantity of concrete placed, and any details or abnormalities of the placement.

Concrete shall not be deposited in running water or in water with a temperature below 35 degrees F.

3.3.7.2 Concrete Placement in Temporary Casing

Temporary casing shall be withdrawn in the approved sequence with placement of the concrete. Withdrawal of the temporary casing shall be carefully coordinated with concrete placement. An adequate head of concrete shall be maintained to exceed the outside soil and water pressure below the bottom of the casing at all times during casing withdrawal. The Contracting Officer's Representative shall be present during the removal of any temporary casing and placing of concrete. The Contractor shall check the concrete level prior to, during, and after withdrawing temporary casing to assure that a separation between the walls of the drilled shaft and concrete has not occurred. The Contractor shall not internally vibrate any concrete before the temporary casing has been completely withdrawn. All temporary casing shall be withdrawn while the concrete is still fluid and plastic. Once placed, concrete shall maintain a minimum slump of five-inches until placement is completed for all subsequent concrete placed as part of the tremie operation and all temporary casing is withdrawn. The methods for placing tremie concrete shall be in accordance with paragarph "CONCRETE PLACEMENT".

3.3.7.3 Placing Equipment

The tremie pipe system shall consist of water tight tubes with gasketed joints and with sufficient rigidity to keep the ends always in the mass of concrete placed. The pipe shall be constructed of heavy gauge steel to withstand all anticipated handling stresses. Alluminum pipe shall not be used. Tremie tubes shall be marked in one-foot increments to allow the distance from the surface to the mouth of the tremie to be determined. If only one tremie pipe is required to place the concrete, the pipe shall be placed near the center of the drilled hole. If multiple pipes are used, they shall be uniformly spaced in the opening. Any internal bracing for steel reinforcing cages shall accomidate the delivery tube system. The pipes shall be fixed horizontally while concrete is flowing in the tremie. Concrete shall be deposited into a charging hopper fastened at the top of the delivery pipe such that there shall be no vertical drop of concrete greater than three feet to the hopper. The concrete hopper shall have a minimum capacity of two cubic yards.

3.3.7.4 Placement Time

The concrete shall be delivered to the placement site at the slump and slump flow specified in Section 03300 GENERAL CONCRETE REQUIREMENTS, Table 1. The concrete shall maintain a minimum 6" slump throughout the concrete placement. The admixtures in the concrete mix shall be adjusted and approved by the Contracting Officer for the conditions encountered on the job so that the concrete remains in a workable plastic state. Slump loss tests shall be conducted to satisfactorily demonstrate that the concrete will maintain a minimum six inch slump for a period of time equal to the estimated transport plus placement time for each structure.

3.3.7.5 Interruption of Concrete Placement

Shaft/pier/cell concrete shall be placed in a continuous, uninterrupted operation. If concrete placement is interrupted for any circumstance that cuases a delay such that the slump of the concrete falls below 5 inches, the concrete placement will stop and the following actions will be implemented:

a) If ten feet or less of the structure has been filled, it shall be pumped or augured out, (after removing reinforcing)the shaft cleaned out and concrete placement restarted.

b) If more than ten feet of the shaft has been filled, the top three feet of the concrete shall be immediately removed and the concrete allowed to set. The concrete surface shall then be prepared as a lift joint and the surface cleaned immediately prior to restarting concrete placement.

3.4 FINISHING

The ambient temperature of spaces adjacent to surfaces being finished shall be not less than 40 degrees F. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, may reasonably be expected to exceed 0.2 pounds per square foot per hour, provisions for windbreaks, shading, fog spraying, or wet covering with a light-colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as finishing operations will allow. All unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish. Additional finishing shall be as specified below and shall be true to the elevation shown in the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown on the drawings and left true and regular. Exterior surfaces shall be sloped for drainage unless otherwise shown in the drawing or as directed. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. Grate tampers or jitterbugs shall not be used.

3.4.1 Unformed Surfaces

3.4.1.1 Float Finish

Surfaces shall be screeded and darbied or bullfloated to bring the surface to the required finish level with no coarse aggregate visible. No water, cement, or mortar shall be added to the surface during the finishing operation. The concrete, while still fresh but sufficiently hardened to bear a man's weight without deep imprint, shall be floated to a true and even plane. Floating may be performed by use of suitable hand floats or power-driven equipment. Hand floats shall be made of magnesium.

3.4.1.2 Trowel Finish

A trowel finish shall be applied to the following surfaces: inverts of filling and emptying system culverts, bulkhead sills, miter gate sills, tops of retaining walls, precast culverts, non-walking surfaces of guide wall concrete elements. Concrete surfaces shall be finished with a float finish, and after surface moisture has disappeared, the surface shall be troweled to a smooth, even, dense finish free from blemishes including trowel marks.

3.4.1.3 Broom Finish

A broom finish shall be applied to the following surfaces: tops of lock walls, all esplanade flatwork, walking surfaces of the guide wall concrete elements and any other horizontal concrete surface that will support foot traffic. The concrete surface shall first be finished with a float finish. The floated surface shall then be broomed with a fiber-bristle brush in a direction transverse to that of the main traffic.

3.4.2 Formed Surfaces

Formed surfaces shall be left with the texture imparted by the forms except that defective surfaces shall be repaired as described in paragraph FORMED SURFACE REPAIR. Unless painting of surfaces is required, uniform color of the concrete shall be maintained by use of only one mixture without changes in materials or proportions for any structure or portion of structure that is exposed to view or on which a special finish is required. The form panels used to produce the finish shall be orderly in arrangement, with joints between panels planned in approved relation to openings, building corners, and other architectural features. Forms shall not be reused if there is any evidence of surface wear or defects that would impair the quality of the surface.

3.4.2.1 Grout-Cleaned Finish

Surfaces to be grout-cleaned shall be moist cured for the required period of time before application of the grout-cleaned finish. Grout-cleaning shall be delayed until near the end of construction on all surfaces not to be painted in order to achieve uniformity of appearance and reduce the chance of discoloring caused by subsequent construction operations. The temperature of the air adjacent to the surface shall be not less than 40 degrees F for 24 hours prior to and 72 hours following the application of the finish. The finish for any area shall be completed in the same day, and the limits of a finished area shall be made at natural breaks in the finished surface. The surface to receive grout-cleaned finish shall be thoroughly wetted to prevent absorption of water from the grout but shall have no free water present. The surface shall then be coated with grout. The grout shall be applied as soon as the surface of the concrete approaches surface dryness and shall be vigorously and thoroughly rubbed over the area with clean burlap pads, cork floats or stones, so as to fill all voids. The grout shall be composed of one part portland cement as used on the project, to two parts by volume of well-graded sand passing a 600-µm (No. 30) sieve mixed with water to the consistency of thick paint. White portland cement shall be used for all or part of the cement as approved by the Contracting Officer to give the desired finish color. The applied coating shall be uniform, completely filling all pits, air bubbles, and surface voids. While the grout is still plastic, remove all excess grout by working the surface with a rubber float, burlap pad, or other means. Then, after the surface whitens from drying (about 30 minutes at normal temperature) rub vigorously with clean burlap pads. Immediately after rubbing is completed, the finished surface shall be continuously moist cured for 72 hours. Burlap pads used for this operation shall be burlap stretched tightly around a board to prevent dishing the mortar in the voids.

3.4.3 Formed Surface Repair

After removal of forms, all ridges, lips, and bulges on surfaces permanently exposed shall be removed. All repairs shall be completed within 48 hours after form removal.

3.4.3.1 Classes A, AHV, & B Finishes

Surfaces listed in Section 03101 FORMWORK FOR CONCRETE and as shown to have classes A, AHV, and B finishes shall have surface defects repaired as follows: defective areas, voids, and honeycombs smaller than 16 square inches in area and less than 1/2 inch deep and bug holes exceeding 1/2 inch in diameter shall be chipped and filled with dry-packed mortar. Holes left by removal of tie rods shall be reamed and filled with dry-packed mortar as specified in paragraph MATERIAL AND PROCEDURE FOR REPAIRS. Defective and unsound concrete areas larger than described shall be defined by 1/2 inch deep dovetailed saw cuts in a rectangular pattern with lines parallel to the formwork, the defective concrete removed by chipping, and the void repaired with replacement concrete. The prepared area shall be brush-coated with an epoxy resin or a latex bonding agent meeting the requirements of Section 03300 GENERAL CONCRETE REQUIREMENTS, or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with paragraph MATERIAL AND PROCEDURE FOR REPAIRS.

3.4.3.2 Class C Finish

Surfaces listed in Section 03101 FORMWORK FOR CONCRETE and as shown shall have defects repaired as follows: defective areas, voids, and honeycombs smaller than 24 square inchesand less than 2 inches deep; bug holes exceeding 1-1/2 inches in diameter shall be chipped and filled with dry-packed mortar; and holes left by removal of the tie rods shall be chipped and filled with dry-packed mortar. Defective and unsound concrete areas larger than 24 square inches and deeper than 1-1/2 inches shall be defined by 1/2 inch deep dovetailed saw cuts in a rectangular pattern, the defective concrete removed by chipping, and the void repaired with replacement concrete. The prepared area shall be brush-coated with an epoxy resin or a latex bonding agent meeting the requirements of Section 03300 GENERAL CONCRETE REQUIREMENTS, or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with paragraph MATERIAL AND PROCEDURE FOR REPAIRS.

3.4.3.3 Class D Finish

Surfaces listed in Section 03101 FORMWORK FOR CONCRETE and as shown to have class D finish shall have surface defects repaired as follows: defective areas, voids, and honeycombs greater than 48 square inches in area or more than 2 inches deep shall be defined by 1/2 inch deep dovetailed saw cuts in a rectangular pattern, the defective concrete removed by chipping and the void repaired with replacement concrete. The prepared area shall be brush-coated with an epoxy resin or a latex bonding agent meeting the requirements of Section 03300 GENERAL CONCRETE REQUIREMENTS, or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with paragraph MATERIAL AND PROCEDURE FOR REPAIRS.

3.4.3.4 Material and Procedure for Repairs

The cement used in the dry-packed mortar or replacement concrete shall be a blend of the cement used for production of project concrete and white portland cement properly proportioned so that the final color of the mortar or concrete will match adjacent concrete. Trial batches shall be used to determine the proportions required to match colors. Dry-packed mortar shall consist of one part cement to two and one-half parts fine aggregate. The fine aggregate shall be that used for production of project concrete. The mortar shall be remixed over a period of at least 30 minutes without addition of water until it obtains the stiffest consistency that will permit placing. Mortar shall be thoroughly compacted into the prepared void by tamping, rodding, ramming, etc. and struck off to match adjacent concrete. Replacement concrete shall be produced using project materials and shall be proportioned by the Contractor and approved by the Contracting Officer. It shall be thoroughly compacted into the prepared void by internal vibration, tamping, rodding, ramming, etc. and shall be struck off and finished to match adjacent concrete. Forms shall be used to confine the concrete. If an expanding agent is used in the repair concrete, the repair shall be thoroughly confined on all sides including the top surface. Metal tools shall not be used to finish permanently exposed surfaces. The repaired areas shall be cured for 7 days. The temperature of the in situ concrete, adjacent air, and replacement mortar or concrete shall be above 40 degrees F during placement, finishing, and curing. Other methods and materials for repair may be used only when approved in writing by the Contracting Officer. Repairs of the so called "plaster-type" will not be permitted.

3.5 CURING AND PROTECTION

3.5.1 Duration

The length of the curing period shall be determined by the type of cementitious material, as specified below. Concrete shall be cured by an approved method. All concrete specified herein shall be cured for a period of 14 days.

Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, and mechanical damage. All materials and equipment needed for adequate curing and protection shall be available and at the placement site prior to the start of concrete placement. Concrete shall be protected from the damaging effects of rain for 12 hours and from flowing water for 14 days . No fire or excessive heat including welding shall be permitted near or in direct contact with concrete or concrete embedments at any time.

3.5.2 Moist Curing

Moist-cured concrete shall be maintained continuously, not periodically, wet for the entire curing period. If water or curing materials stain or discolor concrete surfaces that are to be permanently exposed, they shall be cleaned as required in paragraph APPEARANCE. Where wooden form sheathing is left in place during curing, the sheathing shall be kept wet at all times. Where steel forms are left in place during curing, the forms shall be carefully broken loose from the hardened concrete and curing water continuously applied into the void so as to continuously saturate the entire concrete surface. Horizontal surfaces shall be moist cured by ponding, by covering with a minimum uniform thickness of 2 inches of continuously saturated sand, or by covering with saturated nonstaining burlap or cotton mats. Horizontal construction joints shall be allowed to dry for 12 hours immediately prior to the placing of the following lift. Silica fume concrete, if used, shall be moist-cured. Curing of silica fume concrete shall start immediately after placement.

3.5.3 Membrane-Forming Curing Compound

Concrete on vertical surfaces may be cured with an approved membrane-forming curing compound in lieu of moist curing except that membrane curing will not be permitted on any surface to which other concrete is to be bonded, or on any surface containing protruding steel reinforcement. A styrene acrylate or chlorinated rubber compound may be used for surfaces that are to be painted or are to receive bituminous roofing or waterproofing, or for floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing, or flooring specified and shall conform to ASTM C 309, Type 1D or Type 2. The Contractor shall discuss disposal of any unused or off-spec chemical products in the Solid and Hazardous Waste Management Plan required by Section 01410 ENVIRONMENT PROTECTION.

3.5.3.1 Pigmented Curing Compound

A pigmented curing compound meeting the requirements of the above paragraph MEMBRANE-FORMING CURING COMPOUND may be used on surfaces that will not be exposed to view when the project is completed.

3.5.3.2 Nonpigmented Curing Compound

A nonpigmented curing compound containing a fugitive dye may be used on surfaces that will be exposed to view when the project is completed. Concrete cured with nonpigmented curing compound must be shaded from the sun for the first 3 days when the ambient temperature is 90 degrees F or higher.

3.5.3.3 Application

The curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. The surfaces shall be thoroughly moistened with water, and the curing compound applied as soon as free water disappears. The curing compound shall be applied to unformed surfaces as soon as free water has disappeared and bleeding has stopped. The curing compound shall be applied in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 75 psi, at a uniform coverage of not more than 400 square feet per gallon for each coat, and the second coat shall be applied perpendicular to the first coat. Concrete surfaces that have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. All concrete surfaces on which the curing compound has been applied shall be adequately protected for the duration of the entire curing period from pedestrian and vehicular traffic and from any other cause that will disrupt the continuity of the curing membrane.

3.5.4 Sheet Curing

All surfaces recieving sheet curing shall be thoroughly wetted and be completely covered with waterproof paper or polyethylene-coated burlap having the burlap thoroughly water-saturated before placing. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 12 inches and securely weighted down or shall be lapped not less than 4 inches and taped to form a continuous cover with completely closed joints. The sheet shall be weighted to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period. Sheet curing materials shall conform to ASTM C 171 or COE CRD C 318.

3.5.5 Sealed Insulation Curing

During the periods described in paragraph COLD WEATHER CURING AND PROTECTION where cold weather protection is provided entirely by insulation, all joints in the insulation shall be sealed to retard moisture loss and maintain a seal throughout the curing period. Concrete blankets used for sealed insulation curing shall conform to the requirements of Section 03300 GENERAL CONCRETE REQUIREMENTS.

3.5.6 Cold-Weather Curing and Protection

When the daily outdoor low temperature is less than 32 degrees F, the temperature of the concrete shall be maintained above 40 degrees F for the first 7 days after placing. In addition, during the period of protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the surface will not be subjected to a temperature differential of more than 25 degrees F as determined by observation of ambient and concrete temperatures indicated by suitable temperatures measuring devices furnished by the Government as required and installed adjacent to the concrete surface and 2 inches inside the surface of the concrete. The installation of the thermometers shall be made by the Contractor at such locations as may be directed.

3.6 SETTING OF BASE PLATES AND BEARING PLATES

3.6.1 Setting of Plates

After being plumbed and properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be provided with full bearing with nonshrink grout. The space between the top of concrete or masonry-bearing surface and the bottom of the plate shall be approximately 1/24 of the width of the plate, but not less than 1/2 inch for plates less than 12 inches wide. Concrete surfaces shall be rough, clean, and free of oil, grease, and laitance, and they shall be damp. Metal surfaces shall be clean and free of oil, grease, and rust.

3.6.2 Nonshrink Grout Application

Nonshrink grout shall conform to the requirements of paragraph NONSHRINK GROUT in Section 03300 GENERAL CONCRETE REQUIREMENTS. Water content shall be the minimum that will provide a flowable mixture and fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.6.2.1 Mixing and Placing of Nonshrink Grout

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. The space between the top of the concrete or masonry-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for retaining the grout and shall be removed after the grout has set. If grade "A" grout as specified in ASTM C 1107 is used, all surfaces shall be formed to provide restraint. The placed grout shall be worked to eliminate voids; however, overworking and breakdown of the initial set shall be avoided. Grout shall not be retempered or subjected to vibration from any source. Where clearances are unusually small, placement shall be under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 65 to 85 degrees F until after setting.

3.6.2.2 Curing

Grout shall be cured in conformance with paragraph CURING AND PROTECTION.

3.7 TESTS AND INSPECTIONS

Tests and inspections shall conform to the requirements as specified in Section 03300 General Concrete Requirements. A set of test cylinders shall consist of seven cylinders, two to be tested at 7 days, two at 28 days, two at 90 days, and one held for future testing.

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SECTION 03330

CAST-IN-PLACE ARCHITECTURAL CONCRETE
03/01

PART 1 GENERAL

***3**

This section shall be used for construction of the Service Buildings **and for surface treatments for the Overlook Pavilion**.

***3**

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 211.2	(1991) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 301	(1996) Standard Specification for Structural Concrete
ACI 303R	(1991) Guide to Cast-In-Place Architectural Concrete Practice
ACI 315	(1994) ACI Detailing Manual: Section Details and Detailing of Concrete Reinforcement
ACI 318/318R	(1995) Building Code Requirements for Structural Concrete and Commentary
ACI 347R	(1994) Guide to Formwork for Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1996) Carbon Structural Steel

1.2 GENERAL REQUIREMENTS

All materials, procedures, and requirements specified in Section 03330 General Concrete Requirements and 03301 CAST-IN-PLACE STRUCTURAL CONCRETE shall fully apply to cast-in-place architectural concrete, except as otherwise specified. See 07600, Sheet Metal, General for cast-in place metal reglets used in roof flashing systems. See 09900 Painting and Chemically Stained Concrete for curing requirements of interior concrete walls and floors.

1.2.1 Design Requirements

1.2.1.1 Concrete Mix

The concrete mix shall be designed in accordance with ACI 211.1 and ACI 211.2. The mix design shall include consideration of the finishes required. See also section 03300, General Concrete Requirements.

1.2.1.2 Formwork Design

Formwork design shall conform to ACI 301 and ACI 347R. See also section 03101, Formwork for Concrete.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-04 Drawings

Architectural Concrete; GA, ED

Detail drawings showing details conforming to ACI 315 and ACI 318/318R. Detail drawings shall show location of cast-in-place elements in the work, building elevations, formwork fabrication details, reinforcements, embedments, dimensions, concrete strength, interface with adjacent materials, and special placing instructions, in sufficient detail to cover fabrication, placement, stripping, and finishing.

SD-08 Statements

Contractor Qualifications for Architectural Concrete Installation; GA, RE

Contractor shall retain ACI certified staff as described in ACI 303R for the following areas: Concrete Flatwork Finisher; Concrete Field Testing Technician - grade I; Concrete Construction Inspector - level II.

Contractor shall demonstrate a minimum of 5 years experience in Architectural cast-in-place concrete. Acceptance will be based on previous satisfactory performance.

Contractor shall provide a resume of similar projects involving cast-in-place architectural concrete completed in the past five years. Project information shall include project name, location, date of completion and point of contact.

Concrete Plan; GA,RE.

A plan shall be submitted for approval at least 90 days prior to the start of placement for all concrete covered by this specification. The plan shall show and describe the equipment and methods proposed and shall include, but not be limited to the following:

1) Preparation of foundation and formwork.
2) Batching, including the timing of the introduction of the concrete materials and temperature control.
3) Mixing, including speed and duration.
4) Transportation and conveyance from the mixer to the point of placement.
5) Sampling and testing of concrete.
6) Placing equipment and methods.
7) Procedures for interrupted concrete placement.
8) Consolidation of concrete.
9) Finishing of concrete.
10) Curing and protection of concrete.

The timing and sequence of the various steps shall also be described. The plan shall be of sufficent detail to demonstrate that equipment and methods are appropriate for the specific type of concrete, and that the work conforms to all requirements specified herein. Once approved, the Contractor shall follow all procedures outlined in the plan. Any revisions to the plan shall be submitted to the Contracting Officer for approval.

SD-14 Samples

Materials; GA, ED. Panels; GA, ED

Materials listed below, which shall indicate sizes, shapes, finishes, color, and pertinent accessories: Form ties, form liners, Ohio River washed aggregate and reinforcing chairs.

Sample panels, located as directed, shall be 6 feet long and 4 feet high with the thickness to match building conditions for each type of architectural concrete and finish. Panel forms shall include a typical joint between form panels, form tie conditions and finishes. Panel finishes shall be approved by the Contracting Officers Representative. Panels shall be protected from weather, and other damage until acceptance of work. Sample panels shall be used as job standards throughout construction.

1.4 PAYMENT

Payment for all requirements of this section shall be considered subsidiary with no direct measurement or payment. Payment shall be included within the various concrete pay items.

PART 2 PRODUCTS

2.1 MATERIALS

Except as otherwise specified herein, materials shall conform to Section 03300, General Concrete Requirements. See 07600, Sheet Metal, General for cast-in place metal reglets used in roof flashing systems.
See 09900 Painting and Chemically Stained Concrete for curing requirements of interior concrete walls and floors.

2.1.1 Aggregates

Exposed aggregates shall be in accordance with ASTM C33, #57 stone. Aggregate quality shall conform to ASTM C33, class 5S.

2.1.2 Reinforcing Steel

Reinforcing steel shall be galvanized if clearance to an exterior face is 1 inch or less.

2.1.3 Tie Wire

Tie wire shall be soft monel or 18-8 stainless steel.

2.1.4 Plates, Angles, Anchors, and Embedments

Plates, angles, anchors, and embedments shall conform to ASTM A 36/A 36M, and shall be prime painted with inorganic zinc primer.

2.1.5 Formwork

Formwork for special effects shall be as approved.

2.1.6 Form Release Agents

Form release agents shall be manufacturer's standard, nonstaining, nonpetroleum based, compatible with surface sealer finish coating.

2.1.7 Surface Sealer

Surface sealer shall be methyl methacrylate polymer acrylic emulsion, clear color.

PART 3 EXECUTION

3.1 FORMWORK ERECTION

Formwork shall be erected in accordance with the detail drawings to ensure that the finished concrete members conform accurately to the indicated dimensions, lines, elevations, and finishes. Deflection shall not exceed 1/360th of each component span or distance between adjacent supports. Deflections and tolerance shall not be cumulative. Form lines shall be installed as necessary to provide the required finish. Forms shall be coated with form release agents before reinforcement is placed. Formwork shall conform to ACI 301 and ACI 347R.

3.2 CONCRETE FINISHES

Concrete finishes shall be as indicated below. Finishing shall be accomplished at the time of concrete placement or immediately after formwork removal. Cast-in-place concrete finish elements shall be accomplished by using the following procedures:

3.2.1 Smooth Finish

Unless otherwise indicated, all surfaces on the Service Buildings shall be provided with a grout cleaned finish as described in section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.2.2 Exposed Aggregate Finish

Where indicated, exposed aggregate finishes shall be achieved by applying an even coat of retarder to the face of the forms. After removal of the forms, the indicated areas shall have the aggregate exposed by washing and brushing or light sandblasting away surface mortar. Uniform depth of exposed aggregate shall be medium 1/8 to 1/4 inch reveal of coarse aggregate.

3.2.3 Surface Treatment "A" for Overlook Structure

The areas indicated on the drawings as Surface Treatement "A" shall have an exposed aggregate finish. Aggregates to be exposed shall be washed thoroughly before use to assure satisfactory bond. The aggreagate particles must be completely embedded in the concrete, This can be done by lightly tapping them with a wooden hand float or darby, then, when the concrete can support a finisher on kneeboards, the surface shall be hand floated with a magnesium float or darby until the mortar completely surrounds and slightly covers all the aggregate particles. When the concrete has hardened sufficiently, the aggregate shall be exposed by simultaneously brushing and flushing with water. A retarder can be sprayed or brushed on the surface immediately after floating.

3.2.4 Surface Treatment "B" for Overlook Structure

The concrete areas indicated on the drawings as Surface Treatment "B" for Visitor Overlook, shall be struck off after placing with a template and finished with a float to produce a sandy texture.

3.2.5 Tooled Construction Joints for Overlook Structure

After texturing has been completed, the construction joints of the deck overlay shall be carefully finished with an edging tool to form a smooth rounded surface edge of 1/8-inch radius. No water shall be added to the surface during edging.

3.3 JOINT SEALING

Joint sealing shall be as specified in Section 07900 JOINT SEALING.

3.4 CLEANING

No sooner than 72 hours after joints are sealed, faces and other exposed surfaces of cast-in-place concrete shall be washed down, cleaned with soap and water applied with a soft bristle brush, then washed down again with clean water, or by other approved procedures. Discolorations which cannot be removed by these procedures, shall be considered defective work. Cleaning work shall be done when temperature and humidity conditions are such that surfaces dry rapidly. Care shall be taken during cleaning operations to protect adjacent surfaces from damage.

3.5 SURFACE SEALING

After cleaning, exterior exposed architectural concrete surfaces indicated shall be given one coat of surface sealer, spray applied unless otherwise approved. Adjacent surfaces shall be protected to prevent damage from the surface sealer.

3.6 PROTECTION OF WORK

Work shall be protected against damage from subsequent operations.

3.7 DEFECTIVE WORK

Defective work shall be repaired or replaced, as directed, using approved procedures.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 03 - CONCRETE

SECTION 03700

MASS CONCRETE

-- End of Section Table of Contents --

SECTION 03700

MASS CONCRETE

PART 1 GENERAL

***2 *3**

This specification covers mass concrete placed for the south-middle and land lock walls of the project. This includes the following lock monoliths: SM1-SM7, SM18-SM23, L1-L4, L16-L25 **and the mass concrete stems atop the RCC monoliths.**

***2 *3**

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 305R	(1991) Hot Weather Concreting
ACI 306R	(1991) Cold Weather Concreting

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 94	(2000) Ready-Mixed Concrete
ASTM C 171	(1997a) Sheet Materials for Curing Concrete
ASTM C 309	(1998a) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 928	(1999a) Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs
ASTM C 1064	(1999) Temperature of Freshly Mixed Portland Cement Concrete

CORPS OF ENGINEERS (COE)

COE CRD-C 94	(1995) Specification for Surface Retarders
COE CRD-C 318	(1979) Cloth, Burlap, Jute (or Kenaf)
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete

1.2 UNIT PRICES

1.2.1 Payment

***3**

Payment will be made for costs associated with completing the work for concrete placed in the mass concrete monoliths SM1-SM7, SM18-SM23, L1-L4, L16-L25 **and the mass concrete stems atop the RCC monoliths.** However, these costs will not include the cost of the cement, pozzolan, reinforcement, admixtures, and embedded parts that are specified to be paid for separately. No payment will be made for concrete, as such, that is placed in structures of which payment is made as a lump sum.

***3**

1.2.2 Measurement

Concrete will be measured for payment based upon the actual volume of concrete within the pay lines of the structures as indicated on the drawings. Measurement of concrete placed against the sides of any excavation without the use of intervening forms shall be made only within the pay lines of the structure. No deductions shall be made for rounded or beveled edges, space occupied by metal work, electrical conduits or reinforcing steel, nor for voids or embedded items that are either less than 5 cubic feet in volume or 1 square foot in cross section.

1.2.3 Unit of Measure

Unit of measure: cubic yards.

1.3 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-04 Drawings

Lift Drawings; GA, RE.

A lift drawing and bill of materials shall be furnished for each lift of concrete. (Only one lift shall be shown on a drawing). These drawings shall be to scale and shall show all embedded items in sufficient detail for the proper installation and prosecution of the work. All embedded electrical and/or mechanical items shall be identified. The drawings shall not be less than 22 by 34 inches in size and the scale used shall be sufficiently large to clearly show all details of the structure covered by these drawings. A note shall be included on each lift drawing indicating all contract drawings from which the lift drawing was prepared. The contractor shall submit 2 copies of each drawing for review at least 60 days prior to scheduling the lift for placement.

SD-08 Statements

Concreting Plan; GA,RE

A plan shall be submitted for approval at least 90 days prior to the start of placement for all concrete covered by this specification. The plan shall show and describe the equipment and methods proposed and shall include, but not be limited to the following:

1) Preparation of foundation and formwork.
2) Batching, including the timing of the introduction of the concrete materials and temperature control.
3) Mixing, including speed and duration.
4) Transportation and conveyance from the mixer to the point of placement.
5) Sampling and testing of concrete.
6) Placing equipment and methods.
7) Procedures for interrupted concrete placement.
8) Consolidation of concrete.
9) Joint cleanup and waste disposal.
10) Finishing of concrete.
11) Curing and protection of concrete.
12) Methods and equipment required for protection of Special Temperature Controlled Concrete.

The timing and sequence of the various steps shall also be described. The plan shall be of sufficent detail to demonstrate that equipment and methods are appropriate for the specific type of concrete, and that the work conforms to all requirements specified herein. Once approved, the Contractor shall follow all procedures outlined in the plan. Any revisions to the plan shall be submitted to the Contracting Officer for approval.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

2.1.1.1 Portland Cement

Portland cement shall conform to specifications Section 03300 General Concrete Requirements.

2.1.1.2 Pozzolan

Pozzolan shall conform to specifications Section 03300 General Concrete Requirements.

2.1.1.3 Ground Granulated Blast-Furnace Slag

Ground granulated blast-furnace slag shall conform to specifications Section 03300 General Concrete Requirements.

2.1.2 Admixtures

All chemical and mineral admixtures shall conform to specifications Section 03300 General Concrete Requirements.

2.1.3 Water

Water for washing aggregates and for mixing and curing concrete shall conform to specifications Section 03300 General Concrete Requirements.

2.1.4 Aggregates

Aggregates shall meet the requirements as stated in specifications Section 03300 General Concrete Requirements.

PART 3 EXECUTION

3.1 EQUIPMENT

3.1.1 Capacity

The batching, mixing, conveying, and placing systems shall have sufficient capacity such that placement of the largest lift of concrete on the project can be completed without the formation of cold joints as defined herein.

3.1.2 Batch Plant

The concrete batch plant shall meet the requirements as specified in Section 03300 General Concrete Requirements.

3.1.3 Transporting Equipment

Transporting equipment shall be designed, operated, and maintained so that it does not cause or permit segregation or loss of material. The concrete shall not be dropped vertically more than 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized.

3.1.3.1 Buckets

Bottom-dump buckets shall conform to the following requirements: the interior hopper slope shall be not less than 70 degrees from the horizontal; the minimum dimension of the clear gate opening shall be at least five times the nominal maximum size of the aggregate, and the area of the gate opening shall not be less than 2 square feet; the bucket gates shall be grout-tight when closed, shall be of the double clamshell type, and shall be manually, pneumatically, or hydraulically operated; and the gate-opening mechanism shall be designed to close the gates automatically when the control is released or when the air or hydraulic line is broken. All buckets with a capacity greater than two cubic yards shall not be manually operated. If gate actuation is dependent on integral air or hydraulic reservoirs, the capacity of the reservoirs shall be sufficient to open and close the gates three times without recharging the reservoir.

3.1.3.2 Trucks

Truck agitators used for transporting central-mixed concrete shall conform to the applicable requirements of ASTM C 94. Nonagitating trucks shall not be used. Bodies of agitating and nonagitating trucks shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

3.1.3.3 Chutes

When concrete can be placed directly from an agitating, or nonagitating truck, the chutes supplied by the truck manufacturer as standard equipment may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar equipment shall not be permitted for conveying concrete except when specifically approved and in no case shall slump be increased to accommodate their use.

3.1.3.4 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer or delivery truck to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete or loss of mortar at the transfer point(s) and the point of placing. The idler spacing shall not exceed 36 inches. Belt speed shall be a minimum of 300 feet per minute and a maximum of 750 feet per minute. Belt width shall be a minimum of 16 inches. The NMSA required in mixture proportions furnished by the Government will not be changed to accommodate the belt width.

3.2 PREPARATION FOR PLACING

3.2.1 Vibrators

An adequate number of vibrators shall be on hand to meet placing requirements, and spare vibrators shall be available to maintain production in the event of breakdown. There shall be adequate air pressure available for air vibrators and adequate voltage for electric vibrators. Vibrators of the proper size, frequency, and amplitude shall be used for the type of work being performed in conformance with the following requirements:

APPLICATION	HEAD DIAMETER INCHES	FREQUENCY VPM	AMPLITUDE INCHES
Heavy sections	3 - 6	7,000 - 10,500	0.030 - 0.06
Mass concrete	5 - 7	5,500 - 8,500	0.040 - 0.08

The frequency and amplitude shall be within the range indicated in the tabulation as determined in accordance with COE CRD-C 521.

3.2.2 Embedded Items

Before placing concrete, care shall be taken to determine that all embedded items are securely fastened in place as indicated in the drawings or required. Embedded items shall be free of oil and other foreign matter such as loose coatings of rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Any air or water lines or other materials embedded in structures as authorized construction expedients shall conform to the above requirements and upon completion of their use shall be backfilled with concrete or mortar as directed. Welding will not be permitted on embedded or otherwise exposed metals which are in contact with concrete surfaces. Tack welding of or to embedded items will not be permitted.

3.2.3 Concrete on Rock Foundation

Rock surfaces upon which concrete is to be placed shall prepared in accordance with Section 02217 FOUNDATION PREPARATION. All rock surfaces shall be kept continuously wet for the first 24 hours of the 48 hours immediately prior to placing concrete, and the surface shall be dry with no free water at the time of placement. All approximately horizontal surfaces shall be covered immediately before the concrete is placed with a 1/2 inch layer of bedding mortar. The mortar shall be covered with concrete before the mortar has reached its initial time of setting.

3.2.4 Cold Joint Treatment

If an equipment failure or weather conditions result in the cessation of concrete placement operations while a concrete lift is being placed, a cold joint will be considered to be formed as herein defined. The edge of concrete placement shall be defined as a cold joint either within 1 1/2 hours of the last placement or when the concrete no longer responds to the insertion of a vibrator, whichever comes first. Before fresh concrete can be placed against or over the top of the cold joint, the concrete shall be treated as follows.

3.2.4.1 Vertical Faces of Cold Joints

The concrete shall be jackhammered back to a vertical face all along the face of the cold joint, in a manner satisfactory to the Contracting Officer. After removal of the excess concrete, the surface is to be treated as specified in paragraph "JOINT PREPARATION". After cleaning of the concrete surface is complete, the Contractor shall drill holes for placement of dowels at a vertical spacing of 9 inches and a horizontal spacing of 12 inches across the entire face of the resulting cold joint. The dowels shall be #9 reinforcing bars, 3'-0" long. The dowels shall be placed approximately half-way into the holes. Non-shrink grout shall be placed in the holes prior to dowel placement such that the hole is completely filled after grout placement. After the grout has reached a sufficent strength to resist damage, the vertical face of the cold joint shall be treated as specified in paragraph "JOINT TREATMENT" prior to concrete placement.

3.2.4.2 Horizontal Faces of Cold Joints

The horizontal face of a cold joint shall be treated as specified in paragraph "CONSTRUCTION JOINT TREATMENT".

3.2.5 Construction Joint Treatment

3.2.5.1 Joint Preparation

Concrete surfaces to which other concrete is to be bonded shall be prepared for receiving the next lift or adjacent concrete by cleaning by sandblasting, high-pressure water jet, or air-water cutting. Surface cutting by air-water jets will not be permitted for concrete surfaces congested with reinforcing steel or if they are relatively inaccessible. If, for any other reason, it is considered undesirable to disturb the surface of a lift before it has hardened, the use of sandblasting or high-pressure water jet after hardening will be required. Regardless of the method used, the resulting surface shall be free from all laitance and inferior concrete so that clean, well-bonded coarse aggregate particles are exposed uniformly over the lift surface. Application of the joint treatment method shall be such that the edges of the larger particles of aggregate are not undercut. Where joint preparation occurs more than 2 days prior to placing the next lift or where the work in the area subsequent to the joint preparation causes dirt or debris to be deposited on the surface, the surface shall be cleaned as the last operation prior to placing the next lift. The surface of the construction joint shall be kept continuously wet for the first 24 hours of the 48 hours immediately prior to placing concrete, and the surface shall be dry with no free water at the time of placement.

3.2.5.2 Air-Water Cutting

Air-water cutting of a construction joint shall be performed at the proper time, generally between 4 and 12 hours after placement and only on horizontal construction joints. This period may be modified if a retarder is used to prolong the setting of the cement at surface of the concrete. The air pressure used in the jet shall be 90 to 110 psi, and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. When approved a surface retarder complying with the requirements of COE CRD-C 94 may be applied to the surface of the lift to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, the Contractor shall furnish samples of the material to be used and shall demonstrate the method to be used in its application. After cutting, the surface shall be washed and rinsed until the wash water is no longer cloudy. If air-water cutting does not produce acceptable results, the surface shall be prepared by high-pressure water jet or sandblasting.

3.2.5.3 High-Pressure Water Jet

A stream of water under a pressure of not less than 3,000 psi may be used for cleaning. Its use shall be delayed until the concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse-aggregate particles. If the high-pressure water jet is incapable of a satisfactory cleaning, the surface shall be cleaned by sandblasting.

3.2.5.4 Wet Sandblasting

This method of joint preparation may be used when the concrete has reached sufficient strength to prevent undercutting of coarse aggregate particles. The operation shall be continued until all accumulated laitance, coatings, stains, debris, and foreign materials are removed. The surface of the concrete shall then be washed thoroughly to remove all loose material. This method may be used on both horizontal and vertical surfaces.

3.2.5.5 Waste Water Disposal

The method used in disposing of waste water employed in cutting, washing, and rinsing of concrete surfaces shall be such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal shall meet all requirements of Section 01410 Environmental Protection.

3.3 TRANSPORTING AND PLACING

3.3.1 Transporting

Methods and equipment for conveying and depositing the concrete into the form shall be subject to approval. The capacity of the transporting system shall be sufficient to supply concrete at a rate to prevent cold joints forming during placement. A properly designed and sized elephant trunk and rigid drop chute bottom section which will prevent free-fall within the elephant trunk and rigid drop chute will be used if concrete is to drop more than 5 feet. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the concrete shall discharge into a pipe or elephant trunk that is long enough to extend through the reinforcing bars to within 5 feet of the placing surface. In no case will concrete be discharged to free fall through the reinforcing bars.

3.3.1.1 Transporting by Bucket

There shall be provided indicating and signaling devices for the control of identification of types or classes of concrete as they are mixed and discharged into buckets for transfer to the forms. Each type or class of concrete shall be visually identified by placing a colored tag or marker on a bucket as it leaves the mixing plant so that the concrete may be positively identified in the forms and placed in the structure in the desired position.

3.3.1.2 Transporting by Belt Conveyor

Methods and equipment for transporting the concrete by belt conveyor into the form shall be subject to approval.

3.3.2 Placing

The capacity of the placing system shall be sufficient to supply concrete at a rate which will prevent cold joints in any placement. Concrete shall be worked into the corners and angles of the forms and around all reinforcement and embedded items without permitting the material to segregate. Concrete shall be deposited as close as possible to its final position in the forms, and in so depositing, there shall be no vertical drop greater than 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively placed and consolidated in horizontal layers not exceeding 18 inches in thickness with a minimum of lateral movement. Concrete vibrators will not be allowed to move concrete horizontally. The amount of concrete deposited shall be such that it can be readily and thoroughly consolidated and shall not exceed 4 cubic yards in one pile. All concrete-placing equipment and methods shall be subject to approval. Concrete placement will not be permitted when, in the opinion of the Contracting Officer, weather conditions prevent proper placement and consolidation.

3.3.2.1 Time Interval Between Mixing and Placing

Concrete mixed in stationary mixers and transported by nonagitating equipment shall be placed within 30 minutes after it has been mixed. When an agitating truck is used for transporting concrete mixed by stationary mixers, the concrete shall be delivered to the site of the work, and discharge shall be completed within 1 hour after introduction of the cement to either the water or aggregate.

3.3.2.2 Hot-Weather Placing

The temperature of the concrete when deposited in the forms shall not exceed 70 degrees F. The guidelines in ACI 305R HOT WEATHER CONCRETING shall be followed when concrete is placed during hot weather. Steel forms and reinforcement and conveying and placing equipment shall be cooled if necessary to assist in maintaining specified concrete-placing temperature. The temperature of the fresh concrete shall be measured in accordance with ASTM C 1064.

3.3.2.3 Cold Weather Placing

The temperature of the concrete when deposited in the forms shall not be less than 40 degrees F. The ambient temperature of the placement area and all surfaces to receive concrete shall be above 32 degrees F. The guidelines in ACI 306R COLD WEATHER CONCRETING shall be followed when concrete is placed during cold weather. Materials entering the mixer shall be free from ice, snow, and frozen lumps. The heating of mixing water or aggregates necessary to keep the concrete temperature above 40 degrees F shall be closely regulated so that the concrete temperature does not exceed 60 degrees F. Heating of the mixing water or aggregates will not be permitted until the temperature of the concrete has decreased to 45 degrees F. The materials shall be heated in such a manner that they will be free from ice, snow, and frozen lumps before entering the mixer.

3.3.2.4 Concrete Lifts

***2**

The maximum lift thickness for concrete covered by this section shall be 10 feet. All concrete shall be deposited in approximately horizontal layers about 1-1/2 feet in thickness in stepped progression at such a rate that the formation of cold joints will be prevented. Slabs shall be placed in one lift, unless 2 feet or more deep. Where 7-1/2 foot or greater lift depths are permitted, the Contractor shall furnish approved cantilever forms that are jointed or hinged approximately midheight to facilitate placement against surfaces sloping more than 10 degrees from vertical. At the beginning of the placing of a lift, the top half of a hinged or jointed form shall be retracted to such a position that it does not interfere with the operation of buckets placing concrete adjacent to the form. A minimum of six successive horizontal layers in stepped progression shall be used for 10 foot lifts. A minimum of five successive horizontal layers in stepped progression shall be used for 7-1/2 foot lifts. Where 5 foot lifts are required, a minimum of three successive horizontal layers in stepped progression shall be used. Each new layer of concrete shall be placed on the oldest exposed layer.

***2**

3.3.2.5 Consolidation

Immediately after placing, each layer of concrete shall be consolidated by internal vibrating equipment. Vibrators shall not be used to promote horizontal movement of concrete within the forms. Hand spading may be used if necessary together with internal vibration along formed surfaces permanently exposed to view. Form vibrators shall not be used unless forms are specifically designed for this use and unless specifically approved. The vibrator shall be inserted vertically at uniform spacing over the entire area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding unhardened layer if such exists. It shall be held stationary until the concrete is consolidated and then withdrawn slowly. Slabs 8 inches or less in depth shall be consolidated by approved methods.

3.4 FINISHING

3.4.1 Unformed Surfaces

The ambient temperature of spaces adjacent to surfaces being finished shall be not less than 40 degrees F. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, may reasonably be expected to exceed 0.2 pounds per square foot per hour, provisions for windbreaks, shading, or fog spraying shall be made in advance of placement to prevent plastic shrinkage cracks, and such protective measures shall be taken before, during, and immediately after finishing as operations require. All unformed surfaces of concrete that are not to be covered by additional concrete or backfill shall have a float finish, unless a trowel finish is specified, and shall be true to elevation as shown on the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown and left true and regular. Exterior surfaces shall be sloped for drainage unless otherwise shown in the drawing or directed. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. The concrete shall be thoroughly consolidated before finishing operations commence or before leaving it for future concrete or backfill placement.

3.4.1.1 Float Finish

Surfaces to receive a float finish shall be screeded and darbied or bullfloated to bring the surface to the required finish level with no coarse aggregate visible. No water, cement, or mortar shall be added to the surface during the finishing operation. Floating may be performed by use of suitable hand floats or power-driven equipment. Hand floats shall be made of magnesium. Aluminum floats shall not be used. After the water sheen has disappeared, the concrete, while still green but sufficiently hardened to bear a man's weight without deep imprint, shall be floated to a true even plane.

3.4.1.2 Trowel Finish

A trowel finish shall be applied to the following surfaces inverts of filling and emptying system culverts, bulkhead sills, miter gate sills, and all non-walking surfaces of concrete covered under this section. Concrete surfaces shall first be given a float finish. After surface moisture has disappeared, the surface shall be troweled to a smooth, even, dense finish, free from blemishes, including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. A final hard steel troweling shall be done by hand. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. Surfaces or edges likely to be injured during the construction period shall be protected from damage.

3.4.1.3 Broom Finish

A broom finish shall be applied to the tops of all lock monoliths. The concrete surface to be broom finished shall first be given a float finish. The surface shall then be broomed with a stiff fiber-bristle broom in a direction transverse to that of the traffic.

3.4.1.4 High Velocity Finishes

Unformed surfaces subjected to high velocity flow (40 fps) shall receive a trowel finish.

3.4.2 Formed Surface Repair

After removal of forms, all ridges, lips, and bulges on surfaces permanently exposed shall be removed. All repairs shall be completed within 48 hours after form removal.

3.4.2.1 Classes A, A-HV, & B Finishes

Surfaces listed in Section 03101 FORMWORK FOR CONCRETE, and as shown in the drawings to have classes A, A-HV, and B finishes, shall have surface defects repaired as follows: defective areas, voids, and honeycombs smaller than 16 square inches in area and less than 1/2 inches deep; bug holes exceeding 1/2 inch in diameter shall be chipped and filled with dry-packed mortar; holes left by removal of tie rods shall be reamed and filled with the below specified material; defective and unsound concrete areas larger than described shall be defined by 1/2 inch deep dovetailed saw cuts in a rectangular pattern with lines parallel to the formwork, the defective concrete removed by chipping and the void repaired with replacement concrete. The prepared area shall be brush-coated with an epoxy resin or a latex bonding agent meeting the requirements of Section 03300 GENERAL CONCRETE REQUIREMENTS; or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with the paragraph MATERIAL AND PROCEDURE FOR REPAIRS.

3.4.2.2 Class C Finish

Surfaces listed in Section 03101 FORMWORK FOR CONCRETE, and as shown in the drawings, shall have defects repaired as follows: defective areas, voids, and honeycombs smaller than 24 square inches and less than 2 inches deep; bug holes exceeding 1-1/2 inches in diameter shall be chipped and filled with dry-packed mortar; and holes left by removal of the tie rods shall be reamed and filled with dry-packed mortar. Defective and unsound concrete areas larger than 24 square inches and deeper than 1-1/2 inches shall be defined by 1/2 inch deep dovetailed saw cuts in a rectangular pattern, the defective concrete removed by chipping, and the void repaired with replacement concrete. The prepared area shall be brush-coated with an epoxy resin or a latex bonding agent meeting the requirements of Section 03300 GENERAL CONCRETE REQUIREMENTS; or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with the paragraph MATERIAL AND PROCEDURE FOR REPAIRS.

3.4.2.3 Class D Finish

Surfaces listed in Section 03101 FORMWORK FOR CONCRETE, and as shown in the drawings to have class D finish, shall have surface defects repaired as follows: defective areas, voids, and honeycombs greater than 48 square inchesin area or more than 2 inches deep shall be defined by 1/2 inch deep dovetailed saw cuts in a rectangular pattern, the defective concrete removed by chipping and the void repaired with replacement concrete. The prepared area shall be brush-coated with an epoxy resin or a latex bonding agent meeting the requirements of Section 03300 GENERAL CONCRETE REQUIREMENTS; or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with paragraph MATERIAL AND PROCEDURE FOR REPAIRS.

3.4.2.4 Material and Procedure for Repairs

The cement used in the dry-packed mortar or replacement concrete shall be a blend of the cement used for production of project concrete and white portland cement properly proportioned so that the final color of the mortar or concrete will match adjacent concrete. Trial batches shall be used to determine the proportions required to match colors. Dry-packed mortar shall consist of one part cement to two and one-half parts fine aggregate. The fine aggregate shall be that used for production of project concrete. The mortar shall be remixed over a period of at least 30 minutes without addition of water until it obtains the stiffest consistency that will permit placing. Mortar shall be thoroughly compacted into the prepared void by tamping, rodding, ramming, etc. and struck off to match adjacent concrete. Replacement concrete shall be produced using project materials and shall be proportioned by the Contracting Officer. It shall be thoroughly compacted into the prepared void by internal vibration, tamping, rodding, ramming, etc. and shall be struck off and finished to match adjacent concrete. Forms shall be used to confine the concrete. If an expanding agent is used in the repair concrete, the repair shall be thoroughly confined on all sides including the top surface. Metal tools shall not be used to finish permanently exposed surfaces. The repaired areas shall be cured for 7 days. The temperature of the in situ concrete, adjacent air, and replacement mortar or concrete shall be above 40 degrees F during placement, finishing, and curing. Packaged materials meeting the requirements of ASTM C 928 may be used in lieu of dry-packed mortar when approved. Other methods and materials for repair may be used only when approved in writing. Repairs of the so called "plaster-type" will not be permitted.

3.5 CURING AND PROTECTION

3.5.1 Curing Time

All concrete specified herein shall be cured by one of the following methods or combination of methods for the period of 21 days. Curing shall begin immediately after placing. The Contractor shall have all equipment needed for adequate curing and protection of the concrete on hand and ready to install before actual concrete placement begins. The curing medium and method, or the combination of media and methods used, shall be as approved in accordance with paragraph SUBMITTALS, SD-08 Statements, submittal item "Curing".

3.5.2 Moist Curing

Horizontal and nearly horizontal surfaces shall be moist cured by ponding, by covering with a minimum uniform thickness of 2 inches of continuously saturated sand with continuous supply of water, or by covering with saturated nonstaining burlap or cotton mats. Burlap and cotton mats shall be rinsed to remove soluble substances before using. Other surfaces shall be moist cured when approved or directed. Concrete that is moist cured shall be maintained continuously, not periodically, wet for the duration of the entire curing period. Water for curing shall comply with the requirements of the paragraph WATER. If the water, sand, mats, etc. cause staining or discoloration of permanently exposed concrete surfaces, the surfaces shall be cleaned by a method approved. When wood forms are left in place during curing, the forms shall be kept continuously wet except for sealed insulation curing in cold weather. When steel forms are left in place on vertical surfaces during curing, the forms shall be carefully broken loose from the hardened concrete and curing water continuously introduced into the void. Horizontal construction joints shall be allowed to dry for 24 hours prior to placing the next lift and in accordance with paragraph JOINT PREPARATION.

3.5.3 Membrane Curing

Membrane curing may be used on surfaces that are not specified or directed to receive moist curing. Membrane-forming curing compound shall not be used on surfaces that contain protruding steel reinforcing, that are heated by free steam, or that will have additional concrete bonded to them, including intermediate lift joints.

3.5.3.1 Pigmented Curing Compound

Pigmented compound conforming to ASTM C 309, Type 2, Class A, may be used on surfaces that will not be exposed to view when the project is completed. Only pigmented compound of the styrene acrylate or chlorinated rubber formulation conforming to ASTM C 309, Class B, requirements may be used on surfaces that are to be painted or to receive bituminous roofing or water proofing or floors that are to receive adhesive applications of resilient flooring. The curing compound selected by the Contractor for such use shall be compatible with any subsequent paint, roofing, coating, or flooring specified elsewhere in the contract.

3.5.3.2 Nonpigmented Curing Compound

Nonpigmented compound conforming to ASTM C 309, Type ID, containing a fugitive dye may be used on surfaces that will be exposed to view when the project is completed. The reflective requirements of ASTM C 309 are waived. Surfaces cured with nonpigmented compound shall be shielded from direct rays of the sun for 3 days.

3.5.3.3 Application

The curing compound shall be applied to formed surfaces immediately after the forms are removed. The surfaces shall be thoroughly moistened with water, and the curing compound applied as soon as free water disappears. The curing compound shall be applied to unformed surfaces as soon as free water has disappeared provided steps have been taken when necessary to prevent premature loss of free water due to excessive evaporation as described in paragraph UNFORMED SURFACES. The curing compound shall be applied in a two-coat continuous operation by motorized power-spraying equipment or pressure-tank equipment operating at a minimum pressure of 75 psi with provisions for continuous agitation. The application equipment shall be approved in advance. Hand-operated pressure applicators ("garden sprayers") shall not be used except in small, isolated areas as approved. The compound shall be applied at a uniform coverage of not more than 400 square feet per gallon for each coat. The second coat shall be applied perpendicular to the first coat. Concrete surfaces that have been subjected to rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified. All concrete surfaces on which the curing compound has been applied shall be adequately protected for the duration of the entire curing period from pedestrian and vehicular traffic and from any other influence that will disrupt the continuity of the curing membrane.

3.5.4 Sheet Curing

Sheets shall comply with the requirements of ASTM C 171 or COE CRD-C 318, except that polyethylene sheet shall not be used. All surfaces shall be thoroughly wetted and completely covered with waterproof paper, or polyethylene-coated burlap. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 4 inches and taped to form a continuous cover with completely closed joints. The sheet shall be weighted to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

3.5.5 Sealed Insulation Curing

Between dates listed in paragraph COLD WEATHER PROTECTION where cold weather protection is provided entirely by insulation, all joints in the insulation shall be sealed to retard moisture loss and maintain a seal throughout the curing period.

3.5.6 Protection

No fire or excessive heat shall be permitted near or in direct contact with concrete at any time. No vibratory earth compaction equipment or pile-driving equipment shall be operated within 100 feet horizontally of concrete less than 14 days old nor concrete that has not attained 1000 psi compressive strength. Blasting shall not be permitted within 100 feet horizontally of concrete less than 14 days old nor concrete that has not attained 1000 psi compressive strength. Blasting plans shall be approved by the Contracting Officer. All galleries, conduits, and other openings through the concrete shall be kept closed or sealed during the entire construction period. The surface of the concrete shall be protected from rain or snow during placing.

3.5.7 Cold Weather Protection

Between November 15th of each year and March 15th of the following year, all concrete less than 45 days old shall be covered for a period of 45 days with insulation that provides an R value not less than 2 hour square foot degree Fahrenheit per BTU. The insulation shall be maintained in such a condition that the R value does not diminish during the period of protection. Edges and corners of the placement shall be protected with a double layer of the insulation specified above for a minimum distance of 2 feet in all directions. Concrete placed prior to the starting date shall be insulated from the starting date until it reaches an age of 45 days. Concrete placed after the starting date shall be continuously insulated during and subsequent to placement until the end of the protection period. Forms shall be insulated in such a manner that the combined form-insulation system shall have a thermal resistance (R value) not less than that specified. Insulation and the combined form-insulation system shall remain in place for at least 5 days after placement of the concrete. After 5 days, forms and insulation on vertical surfaces may be removed for periods not to exceed 4 hours in a 24 hour period to allow forms to be moved, and insulation on horizontal surfaces may be removed for periods not to exceed 8 hours in a 24 hour period to allow reinforcement to be installed, insulation to be installed, lift joints to be prepared, etc. provided that suitable precautions are taken to prevent the concrete from being subjected at any time to ambient temperatures of 20 degrees F or below. The first 6 feet of all steel protruding from insulated concrete shall be insulated with material having an R value as stated. All form bolts and metal ribs on the forms shall be insulated in a like manner. During the period of protection there shall be no holes or openings in the insulation or between the insulation and concrete which permit ambient air to penetrate the insulation except as noted for construction purposes. Special attention shall be given to seams, corners, and edges to prevent holes or openings in the insulation.

3.6 THERMAL MONITORING

Thermal monitoring of mass concrete monoliths shall be in accordance with section 013504 VIBRARING WIRE STRAIN GAGES/THERMISTORS. The thermal monitoring gages shall be located as shown on the drawings.

3.7 BASE PLATES AND BEARING PLATES

The setting of base plates and bearing pads shall be in accordance with Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE, paragraph SETTING OF BASE PLATES AND BEARING PLATES.

3.8 BLOCK-OUT CONCRETE

Block out concrete is required in the pintle bases, miter gate sills, culvert valve seals, culvert bulkheads and other areas as shown on the drawings. Block out concrete shall consist of the adjacent concrete with the addition of an expansive admixture as specified herein.

3.8.1 Composition and Proportions

Block-out concrete shall be composed of portland cement, water, fine and coarse aggregate, and admixtures. The concrete mixture proportions, including admixture, will be provided by the Contracting Officer. An expansive admixture shall be used to cause the blockout concrete to expand to fit snugly in the space that confines it. The expansive admixture shall conform to the requirements of Section 03300 GENERAL CONCRETE REQUIREMENTS for expansive admixture. Any block-out concrete not placed within 30 minutes after contact of the cement and admixture shall be wasted. The block-out shall be confined on all sides to provide restraint.

3.8.2 Placing Block-out Concrete

Blockouts shall be provided as shown on the plans for the embedment of gate seal seats, gate guides, bulkhead guides, beams embedded for bulkhead seals, crane rails, and other embedded metalwork as appropriate. Prior to installation of embedded items, the block-outs or recesses shall be cleaned in accordance with applicable requirements of the paragraph on construction joint treatment. After installation of embedded items and prior to placing any forms, all surfaces of the block-outs or recesses and surfaces of items to be embedded shall be thoroughly cleaned of all loose material, oil, grease, and other contaminants which might reduce the bond between the surfaces of the blockouts or recesses and new concrete. Extreme caution shall be exercised in placing block-out concrete to avoid distortion or displacement of the embedded items.

3.9 TESTS AND INSPECTIONS

The testing and inspection of concrete shall be as specified in Section 03300 General Concrete Requirements. A set of test cylinders shall consist of seven cylinders, two to be tested at 7 days, two at 28 days, two at 90 days, and one held for future testing.

-- End of Section --

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SECTION 03701

ROLLER COMPACTED CONCRETE

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SECTION 03701

ROLLER COMPACTED CONCRETE

PART 1 GENERAL

a. The work covered by this section consists of the manufacturing, transporting, placing, compacting and curing of roller compacted concrete. Hereinafter, within these specifications, roller compacted concrete will be referred to as RCC.

b. On this project, RCC will be used to construct the new replacement North and South Lock Chamber Walls from Stations 21+17 through 30+55 and 21+17 through 31+55, respectively. Roller compacted concrete and a conventional slump concrete will be placed concurrently to form a homogeneous and indivisible union at the Lock Wall faces and at the exposed portions of the Lock Wall back slope as shown on the contract drawings.

c. The contractor performing the RCC work on the project shall demonstrate a minimum of 10 years of similar RCC construction. Prior to beginning placing concrete for the Lock Chamber Walls, the contractor will be required to construct a test section wherein specified and proposed construction equipment, methods, and materials will be demonstrated.

d. Information on the production and placement of RCC is available from the American Concrete Institute International, ACI 207.5R, Roller Compacted Concrete and the Corps of Engineers Engineer Manual EM 1110-2-2006, Roller Compacted Concrete.

e. Contract requirements that apply to more than one type of concrete are combined in Section 03300, GENERAL CONCRETE REQUIREMENTS. The specific requirements for RCC are contained in this specification section.

1.1 DEFINITIONS

a. Roller Compacted Concrete is a combination of fine and coarse aggregate, pozzolan, cement and admixture that is blended with water to a damp consistency that permits transporting and spreading with earth moving equipment and compaction with vibratory rollers. Roller compacted concrete, when produced in accordance with these specifications, will have hardened properties similar to conventionally placed mass concrete.

b. Bedding Mortar is a combination of fine aggregate, pozzolan, cement, and admixture blended with water to a workable consistency to permit spreading to a relative thin layer. Bedding mortar will be used on all concrete and rock surfaces to which RCC will be in contact.

c. Dental Concrete, as specified in Section 03300, is a conventional concrete used to fill voids and depressions at or near the surface of the foundation rock in preparation for RCC placement.

d. Crack Starters are contraction joints placed in the facing concrete at intervals between the contraction joints. They provide a means to control cracking in the facing concrete.

e. Contraction Joints provide a weakened plane at locations where RCC cracking can occur. PVC waterstops and joint drains are installed in conjunction with the contraction joints.

f. Facing Concrete is conventional slump mass concrete that is placed against the form surfaces immediately prior to placement of the RCC. Requirements for facing and other cast-in-place or mass concrete are covered in Sections 03300 GENERAL CONCRETE REQUIREMENTS, 03301 CAST-IN-PLACE STRUCTURAL CONCRETE, and 03700 MASS CONCRETE. The facing concrete and the interface with the RCC are vibrated using internal vibrators.

g. RCC Lifts and RCC Layers. RCC will be placed in 24-inch lifts with surface preparation and bedding mortar between each lift. Each lift will be constructed in approximately four (4) 6-inch layers, spread and tracked by the dozer.

1.2 REFERENCES

Section 03300, GENERAL CONCRETE REQUIREMENTS contains the comprehensive listing or related references. The publications listed below form a part of this specification to the extent referenced and are specifically related to RCC construction. The publications are referred to in the text by basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 207.5R	(1999) Roller-Compacted Mass Concrete
ACI 347R	(1994) Guide to Formwork for Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31	(1998) Making and Curing Concrete Test Specimens in the Field
ASTM C 39	(1999) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 138	(2000) Unit Weight, Yield, and Air Content

	(Gravimetric) of Concrete
ASTM C 143	(1998) Slump of Hydraulic Cement Concrete
ASTM C 172	(1999) Sampling Freshly Mixed Concrete
ASTM C 231	(1997e1) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 566	(1997) Total Evaporable Moisture Content of Aggregate by Drying
ASTM C 1040	(1993) Density of Unhardened and Hardened Concrete in Place by Nuclear Methods
ASTM C 1064	(1999) Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1077	(1998) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

CORPS OF ENGINEERS HANDBOOK OF CONCRETE AND AGGREGATES (CRD)

CRD-C 53	(1996) Test Method for Consistency of No-Slump Concrete Using the Modified Vebe Apparatus (27.5 lb. surcharge)
CRD-C 55	(1992) Within-Batch Uniformity of Freshly Mixed Concrete
CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete

CORPS OF ENGINEERS ENGINEERING MANUAL (EM)

EM 1110-2-2006	(2000) Roller-Compacted Concrete

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(1996) Concrete Plant Standards

1.3 UNIT PRICES

1.3.1 Roller-Compacted Concrete (RCC) in Lock Walls

1.3.1.1 Payment

Payment will be made for costs associated with completing the concrete work for roller-compacted concrete placed in the Lock Walls, including all materials and the use of all equipment and tools to complete the concrete work. However, these costs will not include the cost of the cement, pozzolan, water-reducing admixture, and embedded parts that are specified to be paid for separately. Facing concrete, bedding mortar, joint materials, waterstops, sealants, and bond breakers are incidental to the RCC and will be paid for as part of the RCC within the neat lines. No payment will be made for concrete, as such, that is placed in structures of which payment is made as a separate bid item.

1.3.1.2 Measurement

Roller-compacted concrete will be measured for payment on the basis of the actual volume of RCC within the pay lines of the structures as indicated on the drawings. Measurement of RCC placed against the sides of any excavation without the use of intervening forms shall be made only within the pay lines of the structure. No deductions shall be made for rounded or beveled edges, space occupied by metal work, electrical conduits or reinforcing steel, nor for voids or embedded items that are either less than 5 cubic feet in volume or 1 square foot in cross section.

1.3.1.3 Unit of Measure

The unit of measure for RCC is cubic yards.

1.3.2 RCC Test Section

1.3.2.1 Payment

Lump sum payment will be made for costs associated with completing the roller-compacted test section, including all materials, labor, equipment and tools needed to complete the test section.

1.4 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335:

SD-01 Data

RCC Production and Transportation Submittal; GA,ED

Details and data on the RCC production and transportation shall be submitted not later than 120 days prior to proposed test section construction for review by the Contracting Officer for conformance with the requirements of Section 03701. Final acceptance of any piece of plant is subject to satisfactory performance during operations. The following items shall be addressed;

a. Equipment type, manufacturer, model, and layout
b. RCC sampling facilities
c. RCC, facing concrete, and bedding mortar transportation and handling systems from plant to placement area.
d. Batching, including timing of the introduction of the concrete materials and temperature control.
e. Mixing, including speed and duration.
f. Sampling and testing.

RCC Placement Submittal; GA,ED

Details and data on the RCC placement shall be submitted not later than 120 days prior to test section construction for review by the Contracting Officer for conformance with the requirements of Section 03701. Final acceptance of any piece of plant is subject to satisfactory performance during operations. The following items shall be addressed;

a. Equipment type, manufacturer, model, layout and methods.
b. Weather related procedures, cold and hot weather placement.
c. Preparation of foundation and formwork.
d. Procedures for interrupted placement.
e. Compaction procedures and consolidation procedures at interface with facing concrete.
f. Curing and protection.

PART 2 PRODUCTS

2.1 MATERIALS

Requirements for all RCC constituents, including coarse aggregate grading, fine aggregate grading, cementitious materials and all other concrete constituents are specified in Section 03300, GENERAL CONCRETE REQUIREMENTS.

2.2 MIXTURE PROPORTIONING

2.2.1 Composition

All RCC concrete mixtures will be proportioned by the Contracting Officer. RCC shall be composed of cementitious materials, water, fine and coarse aggregates, and water-reducing/retarding admixture. The cementitious material shall be Portland cement in combination with pozzolan. Air-entraining admixture will not be used in the RCC. Approximate proportions for the RCC, exterior facing concrete, and bedding mortar are provided in Table 1 at the end of Section 03300 GENERAL CONCRETE REQUIREMENTS.

2.2.2 Proportioning Responsibility

The proportions of all materials entering the RCC and the conventional concrete will be furnished by the Contracting Officer. The Contracting Officer will change the proportions as necessary. Adjustments will be made to the batch weights, including cement, pozzolan, and water, to maintain the necessary consistency to prevent segregation within the RCC and allow full compaction as determined. Frequent changes to the batch weights of the RCC shall be considered usual and can be expected to occur frequently during the course of each day's placement depending on such variables as humidity, wind velocity, temperature, and cloud cover. Such changes will be as directed. The Contractor will be responsible for adjusting the added water to compensate for changes in aggregate moisture content.

2.2.3 Consistency of RCC

The Contracting Officer will determine at the placement site on a continuing basis the proper consistency necessary for adequate hauling, spreading, and compacting and will direct all necessary changes to achieve the proper RCC consistency. Changes will be directed based on visual examination of the RCC during the spreading and compaction process and on results of the Vebe test when it varies outside the range considered ideal for compaction. The Vebe test will be performed using the modified Vebe apparatus, in accordance with CRD-C 53.

PART 3 EXECUTION

3.1 RCC PRODUCTION PLANT

The Contractor is responsible for securing the required permits prior to beginning construction of the plant. The RCC production plant shall conform to all environmental requirements as required by section 03300 GENERAL CONCRETE REQUIREMTS, paragraph EVIRONMENTAL REQUIREMENTS. The Contractor is also referred to section 01410 ENVIRONMENT PROTECTION, for air and water permitting requirements.

3.1.1 RCC Plant Requirements

A mixing plant shall be provided for the production of RCC. During placement of RCC the plant shall be dedication to the mixing of only RCC. A separate mixing plant shall be utilized for mixing the other concrete mixtures including bedding mortar, facing concrete, and other conventional concrete. The RCC production system, including the RCC plant, conveying, placing, compaction, and cleanup systems shall be designed to maintain a minimum sustained production rate of 200 cubic yards per hour.

3.1.2 Concrete Plant and Mixers

The concrete plant for RCC may be a batch type or continuous mix plant with horizontal internal shaft mixer (pugmill) suitable for mixtures containing up to 3-inch nominal maximum size aggregates. Mixer paddles shall be maintained in a satisfactory operating condition, and kept free of hardened concrete and mortar. Worn or damaged paddles shall be promptly replaced.

3.1.2.1 Location

The concrete plant shall be located at the site of the work in the designated Contractor work area as indicated in the drawings.

3.1.2.2 Plant Tolerances

The accuracy of the plant dispensing systems shall be within the following limits:

POZZOLAN .... 0 to +2 percent
CEMENT .... 0 to +2 percent
WATER .... 1 percent
AGGREGATE .... 2 percent
ADMIXTURES .... 0 to +6 percent

3.1.2.3 Mixer Uniformity Requirements

a. Mixers for RCC shall be tested by the Contractor in accordance with this paragraph and the general requirements of COE CRD-C 55. RCC shall meet at least 5 of the 6 parameters for uniformity as listed below. Uniformity tests shall be performed prior to the start of concrete placement, every six months thereafter and at any time when the Contractor requests a reduced mixing time.

b. The RCC mixture used for the evaluation shall be the standard mixture using the designated nominal maximum size aggregate as directed by the Contracting Officer. Testing shall consist of performing all listed tests on three batches of concrete.

c. For continuous mix plants, RCC shall be sampled at three equally spaced locations on the discharge belt to represent a unit of mixed material greater than 10 cubic yards.

d. If more than one mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, etc., the results of tests on one of the mixers may apply to the others, subject to the approval of the Contracting Officer.

Mixer Uniformity Test Requirements

Test Parameter	Allowable Maximum Range of Test Results, Minimum of Three Samples of Concrete
Unit Weight of air-free mortar, lbs/cu ft	2.0
Air content, percent	0.5
Vebe consistency, seconds	7
Water Content, percent	1.5
Coarse aggregate content, percent	6.0
Compressive Strength at 7 days, percent	10.0

3.1.2.4 Moisture Control

The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the masses of the materials being mixed. A moisture meter complying with the provisions of CRD-C 143 shall be provided for measurement of moisture in the fine aggregate. The sensing element shall be arranged so that the measurement is made near the charging gate of the sand bin or in the sand batcher. Moisture sensors shall not replace moisture content testing using the oven-drying method as specified in paragraph 3.10.

3.1.3 Batch Mixing Plant

3.1.3.1 Bins and Silos

Separate bins, compartments, or silos shall be provided for each size group or classification of aggregate at the plant. Silos or cement tankers shall be provided for bulk Portland cement and pozzolan. The compartments shall be of ample size and so constructed that the various materials will be maintained separately under all working conditions. All compartments containing bulk cement or pozzolan shall be separated from each other by a free-draining air space. The cement and pozzolan bins shall be equipped with filters that allow air passage but preclude the venting of cement or pozzolan into the atmosphere. All filling ports shall be clearly marked with a permanent sign stating the contents. Sufficient cement and pozzolan storage shall be provided on site for at least 20 hours of uninterrupted production.

3.1.3.2 Weigh Batchers

Aggregate shall be weighed in either separate weigh batchers with individual scales or cumulatively. Bulk cement and other cementitious materials shall each be weighed on a separate scale in a separate weigh batcher. Water shall be measured by weight or by volume. It shall not be weighed or measured cumulatively with another ingredient. Ice shall be measured separately by weight. Admixtures shall be batched separately and shall be batched by weight or by volume in accordance with the manufacturers recommendations. The weigh batchers shall be arranged so to permit the convenient addition or removal of material.

3.1.3.3 Water Batchers

A suitable water-measuring and batching device shall be provided that will be capable of measuring and batching the mixing water within the specified tolerances for each batch. The mechanism for delivering water to the mixers shall be free from leakage when the valves are closed. The filling and discharge valves for the water batcher shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. When a water meter is used, a suitable strainer shall be provided ahead of the metering device.

3.1.3.4 Admixture Dispensers

A separate batcher or dispenser shall be provided for each admixture. Only volumetric dispensers shall be used for liquid admixtures and each plant shall be equipped with the necessary calibration devices that will permit convenient checking of the accuracy of the dispensed volume of the particular admixture. The batching or dispensing devices shall be capable of repetitively controlling the batching of the admixtures to the accuracy specified. Piping for liquid admixtures shall be free from leaks and properly valved to prevent backflow or siphoning. The dispensing system shall include a device or devices that shall detect and indicate the presence or absence of the admixture or provide a convenient means of visually observing the admixture in the process of being batched or d ischarged. Each system shall be capable of ready adjustment to permit varying the quantity of admixture to be batched. Each dispenser shall be interlocked with the batching and discharge operations so that each admixture is added separately to the batch in solution in a separate portion of the mixing water in a manner to ensure uniform distribution of the admixtures throughout the batch during the required mixing period. Storage and handling of admixtures shall be in accordance with the manufacturer's recommendations.

3.1.3.5 Scales

Adequate facilities shall be provided for the accurate measurement and control of each of the materials entering each batch of RCC. The weighing equipment and controls shall conform to the applicable requirements of NIST HB 44, except that the accuracy shall be within 0.2 percent of the scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring device. Tests shall be made in the presence of the Government inspector prior to the start of RCC production and at least every two weeks thereafter. Each weighing unit shall include a visible springless dial or digital display that shall indicate the scale load at all stages of the weighing operation and shall show the scale in balance at zero load. The weighing equipment shall be arranged so that the concrete plant operator can conveniently observe the indicators.

3.1.3.6 Operation

The weighing operation of each material shall start automatically when actuated by one or more starting mechanisms and shall stop automatically when the designated amount of each material has been reached. The controls shall be interlocked in such a manner that the discharge device cannot be actuated until the indicated quantity of material is within specified applicable tolerance. These control requirements can be met by providing a semi-automatic batching system as defined in the NRMCA CPMB 100 Concrete Plant Standards. The plant shall include provisions to facilitate the inspection of all operations at all times.

3.1.3.7 Recorders

An accurate recorder or recorders shall be provided to record the batched weights (or volumes) of aggregates, cement, pozzolan, water and admixtures. The recorder shall produce a digital record on a single visible chart of the weight or volume of each material in the batchers at the conclusion of the batching cycle and shall also indicate target batch value of each mix ingredient. The record shall be produced prior to delivery of materials into the mixer. The charts shall be so marked that each batch may be permanently identified and so that variations in batch weights of each type of batch can be readily observed. The charts shall be easily interpreted in increments not exceeding 0.5 percent of each batch weight and shall show the time of day and date. The recorder charts shall become the property of the Government.

3.1.3.8 Protection

The weighing, indicating, recording, and control equipment shall be protected against exposure to dust, moisture, and vibration so that there is no interference with proper operation of the equi
pment.

3.1.4 Continuous Mixing Plant

3.1.4.1 General

The continuous mixing plant shall be capable of producing RCC of the same quality and uniformity as would be produced in a conventional batch plant. The plant shall produce a uniform continuous product throughout the range of possible production rates so that complete intermingling of all ingredients occurs without balling, segregation, and wet or dry portions.

3.1.4.2 Plant Controls

The control system shall have the capability of adjusting RCC proportions for moisture corrections, rapidly changing between at least 3 different mixtures, and of producing any of the mix designs at any selected production rate up to the required plant capacity. The control panel shall display for each ingredient the designed formula values and the instantaneous percentage values and shall record the instantaneous values at a preset time interval or on demand with a multiple copy printer/recorder. The recorder shall note formula changes and shall print total quantities of each ingredient and total amounts produced on command. There shall be weighing devices (belt scales or other) for continuous weighing of individual ingredients and total ingredients. The plant shall be automatic and shall not require manual devices to adjust the material flow. The plant shall be capable of total manual control operation for a single product at a limited production for short-time durations in the event of loss of electronic control.

3.1.4.3 Calibration

The continuous feeders for each of the ingredients shall be calibrated as per the manufacturer's specifications. Devices and tools shall be maintained at the plant location to check the feeder's calibration at the Contracting Officer's request. A factory certified technician skilled in calibration of the feed devices and the maintenance and repair of the plant control system shall perform the initial plant calibrations and shall be available by telephone and on-site within 24 hours when problems arise.

3.1.4.4 Recorders

Multiple copy printer/recorders shall be provided to record instantaneous values for the weight or volume feed rates of aggregates, cement, pozzolan, water and admixtures at a 15-minute time interval and on demand at the Contracting Officer's request. The recorder shall note formula changes and shall print total quantities of each ingredient on demand. The record shall be easily interpreted in increments not exceeding 0.5 percent of the target batch rate for each ingredient and shall show the time of day and date. The recorder charts shall become the property of the Government.

3.1.4.5 Cement, Pozzolan and Aggregate Feed

Cement, pozzolan, and aggregate shall be uniformly, continuously, and simultaneously fed (at the proper ratios and quantity for the desired mixture design) into the mixer by belt, auger, or other acceptable method. The feed bins or silos for each ingredient shall be kept sufficiently full and shall be of sufficient size to ensure a uniform flow at a constant rate for a specific mixture. The feed bins shall have a low-level indicator that both warns the operator and can shut the plant down if insufficient material is available for a uniform and continuous flow. Aggregate feed shall be controlled to prevent segregation in the feed hoppers. The cement and pozzolan feed shall be interlocked with the total aggregate belt scale.

3.1.4.6 Cement and Pozzolan Quantity Verification

Cement and pozzolan feed rate checks shall be performed at least every two shifts of production. The cement and pozzolan feed rates shall be determined by operating the plant and individually discharging a volume of cement and pozzolan equivalent to 20 seconds or more plant time. Recalibration of the plant shall be performed if the cement or pozzolan checks are outside of the specified tolerances. Recalibration of the plant shall also be performed if the quantities of cement and pozzolan used during a shift of RCC placement are outside of the specified tolerances based on haul slips, silo levels and plant recorder records.

3.1.4.7 Water and Admixture Dispensers

The liquid-dispensing devices shall be capable of metering and dispensing within the specified tolerances. The liquid valves shall be free from leakage in the closed position. The dispensers shall have attachments and/or be installed in such a manner that will permit convenient checking of their accuracy. Plumbing shall be leak-free and properly valved to prevent backflow and siphoning. The dispenser shall be interlocked with the electronic plant control and shall warn the operator and shut down the plant if insufficient liquid is available. Separate nozzles for each liquid shall be properly located at the mixer to assure uniform distribution of each liquid to the materials entering the mixer.

3.1.4.8 Continuous Mixer(s)

The continuous mixer(s) shall have proper introduction of ingredients as specified by the manufacturer and shall not be charged in excess of the manufacturer's recommended capacity. Mixer(s) shall be capable of combining the materials into a uniform homogeneous mixture and of discharging this mixture without segregation. The mixer shall operate at the blade speed designated by the manufacturer. Samples for uniformity testing shall be taken at minimum 2-minute intervals and tested in accordance with CRD-C 55 and paragraph 3.1.2.3. The mixer(s) shall be maintained in satisfactory operating condition and mixer blades shall be kept free of hardened concrete. Should the mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired or replaced. Suitable facilities shall be provided for obtaining representative samples of concrete for testing. All necessary platforms, shelters, tools, labor, and equipment shall be provided for obtaining samples.

3.1.4.9 Feed Bins and Silos

Aggregates shall be fed to the mixing plant bins by an approved method. Aggregate hoppers shall have indicators visible to the operator showing the level of aggregates in the plant mixing bins. Silos or cement tankers shall be provided for bulk storage of portland cement, pozzolan or other powders. All compartments containing bulk cement or pozzolan shall be separated from each other by a free-draining air space. The cement and pozzolan bins shall be equipped with filters that allow air passage but preclude the venting of cement or pozzolan into the atmosphere. All filling ports shall be clearly marked with a permanent sign stating the contents.

3.1.4.10 Protection

The weighing, indicating, recording, and control equipment shall be protected against exposure to dust, moisture, and vibration so that there is no interference with proper operation of the equipment.

3.1.5 Laboratory and Sampling Areas

Laboratory working areas and materials sampling facilities shall be provided as specified in Section 03300, General Concrete Requirements. The Contractor shall provide suitable facilities and labor for obtaining representative samples of RCC in accordance with ASTM C 172 for both Contractor quality control and Government quality assurance testing. Facilities for sampling fresh RCC shall be provided such that the plant operation and the flow of material are not interrupted. Acceptable facilities include:

a. A reversing or moveable discharge belt or chute exiting the plant or plant discharge hopper,

b. A rolling or sliding tray sampler that uniformly samples the conveyor discharge.

c. A belt scoop that diverts all the material from a conveyor for a specified period of time.

3.2 PREPARATIONS FOR RCC PLACING

3.2.1 Aggregate Production Schedule

Aggregate production and initial stockpiling shall begin and shall be producing acceptable material by not later than 60 days in advance of the time when placement of the RCC test section is expected to begin. At least 25 percent of all RCC aggregates for each size group necessary for the completed RCC construction shall be manufactured and stockpiled prior to start of placement of RCC for the permanent RCC structures.

3.2.2 RCC Orientation Session

Prior to or in conjunction with the construction of the RCC test section, supervisors and all other Contractor personnel which are expected to participate in the production of RCC for this job (including laborers, equipment operators, foremen, plant operators and QC and inspection staff) shall participate in a 2-hour orientation session organized by the Contracting Officer. The Contractor shall provide a facility suitable for slide and videotape presentation. The intent is to orient all individuals on the goals of the RCC placement process, provide clarification of specification requirements if requested, and be provided orientation as to what constitutes good construction practices. Additional orientation sessions will also be made available to, and shall be attended by, all n ew Contractor personnel who are subsequently hired and that will be involved with the production of the RCC.

3.2.3 RCC Test Sections

3.2.3.1 RCC Test Section I

a. Test Section. Prior to placement of any RCC, the Contractor shall construct a test section. The purpose of the test section is to demonstrate the suitability of the Contractor's equipment, methods, and personnel and to assure that specified production rates can be achieved. The test section shall be at least 3 lifts in height (6-feet) and be at least 50-feet long and 30-feet wide at the top. The Contracting Officer shall approve the site of the test section.

b. Demonstration. The test section shall demonstrate sustained plant production rates, batching, mixing, transporting, spreading, and compaction procedures using actual equipment, materials, and personnel. It shall also demonstrate the vertical face construction method along one side, the sloped face construction method along another side, procedures for foundation and concrete surface preparation and cleanup, procedures for placement of bedding concrete, bedding mortar, and other conventional concrete, and the installation of contraction joints and waterstops.

c. Evaluation. During placement of the test section many method and material evaluations will be done by the Contracting Officer. The Contractor shall perform the density tests and other quality control tests as requested. The full test section shall be sawn at two locations for the full width and depth of the section and the material between saw cuts removed. The test section shall remain until all hardened RCC evaluations are complete and the contractor is directed to removed the test section.

d. Disposition. After evaluation and assessment of the test section by the Contracting Officer, the Contractor shall dispose of the test section in an approved manner. Under no circumstances shall the test section be incorporated into or become a part of the permanent RCC structure.

e. Schedule. The Contractor shall not begin RCC operations for the main structure until testing and evaluations by the Government have been completed on the test section, and it has been demonstrated to the satisfaction of the Contracting Officer that all specification requirements were met. Following completion of the test section construction, 7 calendar days in advance of construction of the main structure shall be allowed for making equipment and method changes. If the Contractor does not meet requirements as specified, an additional test section or sections shall be constructed at no additional cost to the Government.

3.2.3.2 RCC Test Section II

a. General. A second RCC test section shall be constructed after placement of RCC in the lock walls has been completed using the same plant and placing equipment. This test section is to be constructed to investigate alternative methods for constructing vertical formed surfaces and to evaluate RCC lift joint treatments.

b. Test Section Construction. The test section shall be constructed using 12-inch thick lifts and shall be at least 5 lifts in height and at least 50 feet long and 30 feet wide at the top. The test section shall be constructed with vertically formed faces along each 50-foot long side of the test section. The vertical formed faces of the test section shall be constructed using grout-enriched RCC procedures wherein various grout mixtures and RCC are blended in a zone near the formed faces to create a workable mixture with increased durability characteristics. RCC may be delivered using trucks or front-end loaders.

c. Direction by Contracting Officer. For this test section, grout proportions and placement procedures shall be as directed by the contracting Officer. Each lift surface shall be prepared for subsequent RCC lift using lift joint treatments as directed by the Contracting Officer. These treatments may include the use of bonding material (bedding mortar or concrete, grout, cement powder, etc.), varying degrees of maturity (time and temperature), moisture conditioning, and surface retarders. The time between lifts may vary up to 8 hours in duration.

***2**

d. Sample Removal and Disposal. Within 28 days after placement of the test section is completed, the contractor shall saw the test section in two locations (4 saw cuts) for the full width of the section and remove the material between the saw cuts **up to five feet from the form face. The remaining RCC shall be subjected to** laboratory testing and evaluation by the Contracting Officer. Additionally, the Contractor shall drill and remove nominal 6-inch diameter cores from 20 vertical and 10 horizontal locations (150 linear feet) as directed by the Contracting Officer. The test section shall remain until all hardened RCC evaluations are complete and the Contractor is directed to remove the test section.

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3.2.4 Miscellaneous Equipment

All equipment necessary for the successful completion of RCC production, but not discussed within these specifications (or determined to be necessary during the course of the work), shall be approved prior to actual use. Such equipment shall not result in any damage to the RCC, shall be maintained in good operating condition, and shall be operated by skilled contractor-provided personnel.

3.3 TRANSPORTING AND CONVEYING RCC

a. RCC shall be transported from the mixer to the placement site by a means that prevents segregation and contamination of the material, provides RCC at a continuous and uniform flow rate at the placement site, and provides delivery within 10 minutes of discharge from the mixer.

b. The RCC shall be conveyed from the mixing plant using a conveyor or a vehicle system. Vehicles include front-end loaders, end-dump truck, or other approved methods. Vehicles shall not transport RCC onto the RCC surface at any time. Conveyor systems and drop chutes that prevent segregation shall be used to transport the RCC onto the RCC surface.

c. The concrete mixtures (RCC, bedding mortar, conventional facing concrete, and any other concrete that will interface with the RCC) shall be conveyed from the plant mixer(s) to placement as rapidly and as continuously as practical by methods that limit segregation, contamination, and surface drying. Such concretes may be transported by ready-mix truck, conveyor, or agitator truck, or properly designed non-agitating truck. Indicating and signaling devices shall be provided as directed by the contracting officer for the control and identification of types of concrete as they are mixed and discharged for transfer to the placement site.

3.3.1 Contamination

All equipment, including service equipment that enters onto the RCC surfaces of the lock wall, must be cleaned by an approved method to remove all contaminants prior to entering onto the RCC surface. Water spray is not an acceptable method due to the subsequent dripping of contaminants and water onto the RCC. Equipment may be serviced on the finished RCC surfaces provided a protective device or covering is used to protect the underlying RCC from contamination. Equipment that causes contamination of the RCC shall be removed from the placement area. RCC that is contaminated with oil or other contaminants shall be removed and wasted.

3.3.2 Belt Conveyors

a. Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer or delivery truck to final place of deposit without segregation of ingredients or loss of mortar. The conveyor shall be provided with positive means for preventing segregation of the concrete or loss of mortar at transfer points and the point of placing. Conveyor belts shall be of ample width and operated at speeds that meet production requirements and do not segregate the mixtures. Conveyor belts shall not be operated at steep inclines that result in segregation of the RCC mixtures and shall be fitted with conveyor wipers that are properly adjusted to prevent the dripping or loss of mortar.

b. Mixer material that has been on the conveyor for more than 10 minutes shall be wasted or otherwise disposed of as directed by the Contracting Officer. The NMSA required in mixture proportions furnished by the

Government will not be changed to accommodate the belt width.

c. The belt conveyor system shall be designed and manufactured by personnel fully experienced with conveyor belt delivery of RCC and shall be specifically designed for continuous operation. The belt conveyor system shall be maintained in accordance with the manufacturers recommended practice and an adequate inventory of replacement components and parts shall be maintained at the job site.

d. Mobile conveyor systems that can travel to various locations, extend and retract, and rotate are acceptable systems for RCC transportation.

3.3.3 Gob Hopper

If used, gob hoppers shall be constructed with adequate capacity so that RCC production is not stopped or slowed if hauling vehicles are delayed. Gob hoppers shall be constructed with side slopes and gates that allow for the free flow of RCC without segregation or choking. Radio communication shall be provided between the gob hopper, the mixing plant control room, and the placement site. Gob hoppers shall be completely emptied of all of one mix before filling with a different mix. Gob hoppers shall be easily moved or elevated with no system downtime and without causing segregation or other damage to the RCC.

3.3.4 Transporting RCC on RCC Surfaces

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The RCC shall be conveyed along the lock wall by means of conveyor or other non-vehicular method. The use of front-end loaders and end-dump trucks will not be permitted on the RCC surface for transportation of RCC **unless specifically approved for use in unusual or restricted spaces**. RCC shall not be placed on a compacted RCC surface and subsequently picked up with a loader or other equipment and reused. Segregated RCC (rock pockets) shall be removed. The Contracting Officer shall approve any remixing of segregated material into the fresh RCC.

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3.4 PLACING RCC

3.4.1 Weather Limitations on Placement

If unusual adverse weather, such as heavy rain, severe cold, high winds, heavy snow, etc., occurs or is forecast to occur during placement, the placement operation shall be suspended until conditions improve.

3.4.1.1 Cold-Weather Placement

RCC shall not be placed when the ambient air temperature drops below 32 degrees F. When the ambient air temperature is below 32 degrees F, RCC surfaces already in place shall not remain exposed for longer than 4 hours. Surfaces that will be exposed for longer times shall be protected as specified in paragraph: Cold Weather Protection.

3.4.1.2 Placing During Rain

RCC shall not be placed during rainfall of 0.1 inch/hr or more. During periods of lesser rainfall, placement of RCC may continue if, in the opinion of the Contracting Officer, no damage to the RCC is occurring. Work shall commence only after excess free surface water and contaminated paste or RCC have been removed and the RCC surface has gained sufficient strength but no less than 4 hours after the RCC placement was suspended. Measures shall be implemented to prevent rutting, pumping, intermixing of rainwater with the RCC, or other damage to the RCC. When the RCC surface has been contaminated or damaged in any manner, the RCC surface shall be washed to break up and remove laitance and/or mud-like coatings from the surface. Any undercut coarse aggregate shall be removed. All waste shall be removed and disposed of in accordance with Section 03300.

3.4.1.3 Hot-Weather Placement

Placement of the RCC shall be controlled so that the temperature of the RCC does not exceed 80.0 degrees F when placed. Placement shall be suspended as soon as the RCC temperature exceeds 80 degrees F. Measures that can be taken to help reduce the RCC temperature include, but are not limited to, chilling mixing water, sprinkling aggregate stockpiles, placing during nighttime and early morning hours, or restricting placements to cloudy days. Use of any of these systems shall not be reason for extension of completion dates specified in these specifications.

3.4.2 Placing Procedures

a. General. It is the intent of this contract to raise each lock wall at essentially the same level across the entire horizontal surface area. For the lock walls, placement shall proceed from one end of the lock wall to the other and each lift shall be completed in its entirety across the full width of the wall. As the advancing edge of the lift progresses, the exposed leading edges shall be kept "live" by progressively placing out from the advancing edge in a sloping and uniform fan-like manner. RCC shall only be placed on prepared RCC surfaces. No RCC or other concrete shall be placed on a previous lift that has not met specification requirements. Unacceptable material shall be removed and wasted.

b. Alternative. In order to facilitate the use of limited reach conveyor systems, the lockwall may be subdivided into no more than 3 individual placements that are coincident with designated contraction joints. Vertical forms shall be used between placements that are no greater than 10 feet in height. RCC placement shall not advance more than 10 feet higher than the adjacent RCC placement.

c. Depositing. RCC shall be deposited from the conveyor or drop chute on the uncompacted RCC of the advancing edge in a forward direction from the dump pile. RCC shall not be placed in consecutive or consistent lanes and not be placed on compacted RCC surfaces except at the beginning placement of a lift. The dump location shall be varied to avoid "lane" construction. RCC shall not free fall more than 4 feet or be piled higher than 4 feet during spreading. Except for specifically approved locations, RCC shall not be spread by dozer more than 15 feet from the point of deposit. Excep t at the beginning of an RCC lift, RCC shall be placed on uncompacted RCC and spread onto the previously compacted RCC lift using a dozer.

d. Spreading. After the RCC has been deposited, the RCC shall be spread by dozers into gently sloping layers, approximately 6 inches thick, that will, after final compaction of the several layers by the vibratory roller, result in the specified lift thickness. During the spreading process, the dozer operators shall continuously work the RCC surfaces with the dozer blade and grousers in a manner to remix any RCC that may contain pockets of segregated material and to compact the material. All surfaces of each layer shall receive at least two passes with the grousers. The dozers shal l be operating continuously during the spreading process, even if this action results in more than two passes.

e. Confined Areas. A front-end loader with operator shall be available to assist with depositing and spreading RCC as needed in confined areas, at the abutments, and at other locations approved or directed.

f. Time limits. In no case shall the RCC, bedding mixes, or bedding mortar be allowed to dry. The interval between batch plant mixing and final RCC compaction shall be no greater than 45 minutes. Final compaction is defined as any RCC lift placed in multiple fan type layers that have been worked by dozer grousers, have received a minimum of four passes with the vibratory roller, and meets the specified density requirements.

3.4.3 Spreading and Remixing Equipment

a. Primary Equipment. The primary spreading procedure shall be accomplished by tracked dozer. For open, unrestricted areas, the dozer shall be a minimum size and weight equivalent to a Caterpillar D-6. For restricted placement areas, such as placement of RCC near the top of the lock walls, the dozer shall have as a minimum a size and weight equivalent to a Caterpillar D-4. The dozers shall be equipped with well maintained grousers. There shall be a minimum of one operating dozer for each 200 cubic yards of RCC placed each hour.

b. Other Equipment. A front-end loader with operator shall be available to assist with deposition and spreading of RCC as needed. Graders or other equipment not specified may be used to facilitate the RCC spreading process only when approved.

c. Operation. Under no conditions shall a dozer or other tracked vehicle be operated on other than fresh uncompacted RCC except to facilitate startup operations for each lift and by approved procedures.

d. Contamination. The equipment shall be maintained in good operating condition and shall not leak or drip oil, grease, or other visible contaminants onto the RCC surface. All equipment used for spreading and remixing that leaves the surface of the RCC structure for maintenance or repairs or, for any other reason, must be cleaned of all contaminants by an approved method before returning to the structure surface.

3.4.4 Bedding Mortar

Bedding mortar shall be applied to all surfaces to receive subsequent RCC lifts. The bedding mortar shall be applied following the applicable regular or cold treatment and shall be applied not more than 15 minutes ahead of RCC placement, unless otherwise approved. The bedding mortar shall be used between hardened conventional concrete and RCC, between different RCC placements, and at other locations as directed or as shown in the drawings. The bedding mortar shall have an average thickness after application of between 1/4 and 1/2 inch and shall cover 100 percent of the lift area.

3.4.5 RCC Lift Thickness

The total lift thickness after final compaction by the vibratory roller shall be 24 inches.

3.5 COMPACTION AND CONSOLIDATION

3.5.1 GENERAL

a. All RCC shall be compacted to a minimum of 98 percent of the OCD value. The anticipated OCD, estimated from laboratory test data is approximately 152.0 pounds per cubic foot.

b. Density shall be measured using a nuclear density meter in accordance with ASTM C 1040. RCC density value determinations shall be made continuously throughout the course of RCC placement to assure that the RCC is compacted to a minimum 98 percent of the OCD and detect segregation and/or voids throughout the RCC.

c. After spreading and working with the dozers, the top surface of each lift shall be compacted with a minimum of four, plus as many additional passes with a self-propelled double-drum vibratory roller operating in the vibratory mode as are required to obtain the required density. A round trip over the same material shall count as two passes (i.e., from point A to point B and return to point A by the same route is two passes). Rollers shall not be operated in the vibratory mode unless moving. Any conventional concrete that interfaces with the RCC shall be consolidated with internal vibrators.

3.5.2 Compaction Equipment

3.5.2.1 Primary Rollers

Self-propelled steel double drum vibratory rollers shall be used for primary rolling. They shall transmit a dynamic impact to the surface through the smooth steel drums by means of revolving weights, eccentric shafts, or other equivalent methods. The compactor shall have a minimum gross mass of 20,000 pounds and shall produce a minimum dynamic force of 350 pounds per linear inch of drum width. The operating frequency shall be variable in the approximate range of 1,700 to 3,000 cycles per minute. The amplitude shall be adjustable between 0.015 and 0.04 inches. The roller shall be capable of full compaction in both forward and reverse directions. The roller shall be operated at speeds not exceeding 2.2 ft/s. Within the range of the operating capability of the equipment, the C ontracting Officer may direct or approve variations to the frequency, amplitude, and speed of operation which result in the specified density at the fastest production rate. At least one additional self-propelled vibratory roller shall be maintained full time at the site and ready for service at all times during production and placement.

3.5.2.2 Small Vibratory Rollers

Small vibratory rollers shall be used to compact the RCC where the larger vibratory rollers specified above cannot maneuver. The rollers shall compact the RCC to the required density and shall be so demonstrated during construction of the test section. Small vibratory rollers cannot compact the RCC to the same density and thickness as the primary rollers; therefore, when small rollers are used, total lift thickness of the RCC layer or lift shall be reduced to not over 12 inches uncompacted thickness to permit adequate compaction. Small vibratory rollers shall have a minimum gross mass of at least 1200 pounds and shall produce a minimum dynamic force of 150 pounds per linear inch of drum width. The operating frequency and amplitude shall be within the range specified for primary rollers. At least one small vibratory roller shall be maintained full time at the site and ready for service at all times during production and placement.

3.5.2.3 Tampers (Rammers)

Tampers, if used, shall compact the RCC to the required density and shall be so demonstrated during construction of the test section. Tampers shall have a minimum weight of 120 pounds and a tamping frequency of 400 to 600 blows per minute. Tampers cannot compact the RCC to the same density and thickness as the primary rollers; therefore, when tampers are used, thickness of each RCC layer that is to be compacted shall be reduced to not more than 12 inches uncompacted thickness to assure adequate compaction.

3.5.2.4 Plate Compactors

Plate compactors, if used, shall compact the RCC to the required density and shall be so demonstrated during construction of the test section. Plate compactors shall have a minimum weight of 150 pounds and a minimum vibration frequency of no less than 4000 cycles per minute. Plate compactors cannot compact the RCC to the same density and thickness as the primary rollers; therefore, when used, thickness of each RCC layer that is to be compacted shall be reduced to not more than 12 inches uncompacted thickness to assure adequate compaction.

3.5.3 Nuclear Density Gauge

Tests to determine the density of both the uncompacted and compacted RCC shall be made by the Contractor using nuclear density gauges. The nuclear density tests shall be made using single and dual probe gauges, both of which shall be supplied by the contractor and available throughout the entire duration of RCC placement. The nuclear density gauges shall meet the applicable requirements of ASTM C 1040. The dual probe gauge shall be capable of taking readings along a horizontal path between the probes at

2-inch increments from 2 inches to 24 inches below the surface. The si ngle gauge shall be capable of taking readings at 2-inch depth increments from 2 inches to 12 inches below the surface. The gauges and operator shall be made available to the Government until completion of all RCC production at no additional cost. The Contractor shall obtain all permits and certifications for the equipment and the operators.

3.5.3.1 Factory Calibration

Nuclear gauges shall have been factory calibrated within 6 months of RCC placement.

3.5.3.2 Nuclear Gage Field Calibration Test Block

The Contractor shall construct, at no additional cost to the Government, a nuclear gage field test block with minimum dimensions of 4 ft along each side. The block shall be constructed of RCC and compacted using a pneumatic pole tamper or other means to 98-percent of the theoretical design density based on actual weight and volume measurements of the block. As an alternate, the block shall be constructed of conventional concrete, properly consolidated with an internal vibrator. The mixture proportions will be provided by the Contracting Officer. Nuclear density tests shall be made on the completed block with both the single and dual probe gauges and the resulting probe holes in the freshly placed RCC (or conventional concrete) will be carefully maintained to allow additional nucle ar density testing on the hardened block. The hardened block shall be weighed and measured in air or weighed in air and water to determine unit weight. Gauge calibration constants shall be adjusted for performance on the blocks prior to the evaluation of test strips. The Contractor shall remedy any inconsistencies in gauge performance prior to the start of RCC placement and after the start of RCC placement, gauges shall be field recalibrated against the RCC density block at least every 24 hours.

3.5.4 Internal Vibrators

Internal vibrators shall be used to consolidate the conventional facing concrete and the interface between conventional concrete and RCC. The vibrators shall consist of a minimum of six vibrators that are "gang-mounted" in a 2 x 3 matrix on the boom of a backhoe or similar chassis. The distance between vibrators shall be approximately one and one-half times the radius of action of the individual vibrator. The vibrators shall have a 3 to 4-inch head diameter, a frequency of 7,000 to 10,500 vpm and an amplitude of 0.03 to 0.06-inches. The frequency and amplitude shall be determined by the Contractor, in the presence of a Government representative in accordance with CRD-C 521. An adequate number of vibrators shall be on hand to meet placing requirements, and spare vibrators shall be available to maintain production in the event of breakdown.

3.5.5 Optimum Compaction Density (OCD) Determination

3.5.5.1 General

In order to account for changes in material properties and proportions within the specification limits, the required minimum density will be determined using the optimum compaction density (OCD) method. All OCD determinations will be made in the presence of the Contracting Officer. OCD compaction shall commence within 15 minutes after final mixing of the RCC. The OCD shall be invalid if it is determined that material proportions (including water) are outside the designated range.

3.5.5.2 Initial OCD Determination

The initial OCD value shall be determined during placement of the RCC test fill. The density of the RCC shall be determined concurrently for every 1 pass of the compaction equipment in two locations of the test fill. Compaction equipment passes and density determinations shall continue until density decreases significantly. The OCD shall be the average maximum recorded density in pounds per cubic foot. A variation in OCD from the two locations of more than 2 pounds per cubic foot shall invalidate the test and shall require that another test set be performed. The number of roller passes to achieve OCD shall be a guide to the equipment operators of the required compaction necessary to achieve OCD.

3.5.5.3 Subsequent OCD Determination

As RCC placement progresses, subsequent OCD testing shall be performed at the placement site at least once every 6 shifts of RCC placement and at a lesser frequency as determined by the Contracting Officer as RCC placement progresses.

3.5.6 Consolidation of Conventional Facing Concrete and Interface with RCC

Consolidation of the conventional facing concrete and the interface between the RCC and convention facing concrete shall be accomplished using gang-mounted vibrators attached to the boom of a backhoe or similar chassis as described in paragraph 3.5.4. The vibrators shall be inserted vertically at uniform spacing over the entire area of conventional concrete and the RCC interface placement zone. The vibrator shall penetrate rapidly to the bottom of the facing concrete and at least 6 inches into any preceding plastic layer if such exists and at least 12 inches into the RCC at the interface. The vibrators shall be held stationary until the entrapped air is forced to the surface (up to 6 seconds) and the concrete is consolidated and then withdrawn slowly. In no case shall vibrators be used to transport concrete.

3.6 HORIZONTAL LIFT JOINTS

The entire RCC mass shall be placed with sufficient continuity so that it hardens and acts without discontinuous joints or potential planes of separation. All lift joints shall be kept clean, uncontaminated, free from ponded water, and continuously moist until placement of the succeeding RCC or other concrete.

3.6.1 Cleaning Surfaces

a. General. All lift surfaces including any RCC or other conventional concrete shall be cleaned prior to placing any additional concrete thereon.

The prepared surfaces shall be clean and free of loose or deteriorated rock; all mud and silt accumulations; vegetation; laitance; puddles or ponds of free surface water; coatings; and any other detrimental materials. Adequate equipment with operators shall be on hand at the site to clean all surfaces in conformance with these specifications without disrupting in any way the RCC production as scheduled.

b. Standard Surface Cleaning. Lift joints that are less than 72 hours old shall be cleaned using high-volume low-pressure water washing and/or air water jetting, and vacuuming. The air-water jets shall have 1-1/2-inch nozzles, a water supply of at least 30 gpm, and compressed air at the jet of 80 to 120 psi. The low-pressure water jets shall have 1-inch nozzles and a capacity of at least 200 gpm for truck-mounted devices.

c. Cold Joint Surface Cleaning. Lift joints that are older than 72 hours or lift surfaces that are severely contaminated or damaged shall be treated as cold joints and cleaned using a high-pressure water jet or wet sandblasting, and vacuuming. The high-pressure water jet shall deliver a stream of water under a pressure of not less than 1,500 psi for RCC and 4,000 psi for conventional concrete. There shall be no undercutting of coarse-size aggregates. Aggregate particles that are undercut shall be removed. For cleaning large open areas, the high-pressure water jet system may be truck-mounted. For cleaning small or confined areas, the high-pressure water jet system shall be portable.

d. Alternate Methods. Other methods utilizing brushing in combination with water and air may be used if successfully demonstrated during test section construction.

e. Bedding mortar shall be applied to all lift surfaces and surfaces against which RCC is placed. Bedding mortar not meeting these specifications shall be removed and the underlying surface prepared as a cold joint. All surfaces upon which bedding mortar is placed shall be moist but shall contain no visible free water. No surfaces to receive bedding mortar shall be covered with RCC until the prepared surfaces have been accepted in writing and that acceptance has been recorded on an approved checkout form.

3.6.2 Truck-Mounted Vacuum Pickup System

A truck-mounted vacuum pickup system shall be provided for various cleanup operations from the beginning of foundation cleanup until RCC placement is at least 2 lifts above the foundation rock. The unit(s) shall be capable of pumping 4,500 cubic feet of air per minute through an 8-inch diameter opening and capable of pumping water at a minimum rate of 2,000 gpm. The equipment shall be maintained in good operating condition and shall not leak cleanup water and other debris during equipment operation or transit. The equipment shall not leak or drip oil, grease, or other visible contam ination onto the RCC.

3.6.3 Waste Disposal

Any waste water employed in cutting, washing, and rinsing of concrete surfaces, and any other surface water shall not stain, or affect exposed surfaces of the structure(s) or damage the environment of the project area. Disposal shall comply with the provisions of Section 01410 ENVIROMNMENT PROTECTION.

3.6.4 Vertical Joints Within a Lift

Joints for sloping, near-vertical or vertical RCC surfaces are considered to be vertical joints. A vertical joint most often will occur when an RCC placement is terminated before the entire RCC placement for that lift has been completed. When it does become apparent that placement of RCC will be terminated prior to completion of a lift, the RCC spreading procedure at the leading zone of the placement shall be adjusted to provide a steeply tapered slope to complete that lift. The taper shall be no greater than 3 horizontal on 1 vertical. Where the tapered slope meets the underlying hardened lift surface, care shall be taken to prevent or remove any segregated or uncompacted material. The tapered surface shall be compacted in accordance with paragraph 3.5. Prior to resumption of RCC placements, the tapered surface shall be prepared using applicable regular or cold joint treatments.

3.7 Contraction Joints

a. General. Contraction joints shall be formed by inserting plates into non-compacted full lift thickness RCC at locations as shown on the drawings. The plates, when installed adjacent to each other (at the same structure stationing within each lift) shall form a bond breaker that serves as a contraction joint. The plates shall be installed vertically into the RCC by means of a vibrating plate mounted on a backhoe. Plate alignment shall be controlled by survey techniques. Waterstops, drains, and contraction joints within any conventional concrete shall be in accordance with Section 03151 EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS IN CONCRETE FOR CIVIL WORKS, and as shown on the drawings.

***3**

b. Material. The plates shall be a minimum of 36 inches wide and 20 inches deep and shall be made of steel. Steel plates shall be galvanized sheet steel with a minimal thickness of 0.014 inches **after galvanization.**

***3**

c. Alternate methods of joint construction are subject to approval by the Contracting Officer and shall be demonstrated in the test section. The exact details for the design of the contraction joints, as well as installation and methods of maintaining tolerances, alignment, etc., shall be submitted in accordance with paragraph SUBMITTALS.

3.8 VERTICAL FACINGS FOR RCC CONSTRUCTION

General. The vertical faces and selected backslopes of the RCC structure are to be constructed using a form and cast-in-place conventional concrete system as shown and specified.

Demonstration. The vertical facings system shall be demonstrated on one side of the RCC test section. In construction of the conventional concrete facings, a 2.0 foot wide zone of conventional concrete shall be placed against the forms. The Contractor's construction techniques and equipment used shall be satisfactorily demonstrated during construction of the test section.

Formwork. The design and engineering of the formwork, as well as its construction, shall be the responsibility of the Contractor. The formwork shall be designed for loads, lateral pressure, and allowable stresses in accordance with Chapter 1 of ACI 347R. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete and shall have sufficient rigidity to maintain specified tolerances.

Sequence. The required sequence of construction operations after all forms and concrete surface preparations have been approved is:

(1) place conventional concrete full height of each RCC lift and full width against the forms;

(12) spread each thin RCC layer into and abutting against the conventional concrete while at the same time tracking the interface between the two with dozer grousers;

(3) after full-lift thickness of the RCC is in place next to the conventional concrete, consolidate 100 percent of the conventional concrete and the interface using internal vibrators;

(4) and finally, compact the RCC and interface using the vibratory roller. The interface between the RCC and conventional concrete shall be consolidated and "knitted" together using the gang he
avy-duty, machine-mounted, immersion vibrators prior to final consolidation rolling of the RCC lift.

3.9 CURING AND PROTECTION

3.9.1 Curing

3.9.1.1 General

Unless otherwise specified the curing period of all RCC and conventional concrete surfaces shall be 21 days. Water for curing shall comply with the requirements for mixing water.

3.9.1.2 RCC Surfaces

a. Moist Cure. The surface of every RCC lift shall be kept continuously moist, commencing immediately after compaction for 21 days or until the surface is covered with the next lift. The sloping backslope RCC surfaces of the lock walls shall receive a continuous 21-day application but shall not require temperature protection. RCC against which backfill is placed shall be moist cured continuously for 21-days or until placement of backfill.

b. Water Application. Curing water shall be applied in a manner that does not erode the paste from the surface of the RCC. Light, frequent applications shall be done rather than heavy infrequent applications. Any RCC surface that has been allowed to dry will be considered a cold joint and surface preparation for cold joint shall be done before the application of bedding mortar.

3.9.1.3 Facing Concrete Surfaces

Curing and protection for all conventional concrete used in the construction of the vertical faces and any horizontal RCC surfaces that will not receive a subsequent concrete covering shall be moist cured.

3.9.2 Cold-Weather Protection

The air and forms in contact with the RCC and any facing concrete shall be maintained at a temperature above 32 degrees F for 21 days. In addition, at the time insulation or protection is removed, the air temperature adjacent to the RCC surfaces shall be controlled so that the concrete near the surface will not be subjected to a temperature differential of more than 25 degrees F (as determined by observation of ambient air and concrete temperatures).

3.9.3 Special Cold-Weather Insulation Protection

a. RCC and facing concrete surfaces shall be continuously covered with insulation blankets between the dates of 15 November and 15 March. Insulation shall have a conductivity of at least 0.22 BTU/(hr-degF-sf),(R value = 4.55). The Contracting Officer may modify the specified times and duration of insulation based on actual temperature conditions. These requirements are in addition to those in paragraph 3.9.2 Cold-Weather Placement.

b. When cold weather conditions require termination of RCC placement for more than 4 hours, RCC surfaces shall be protected with insulation that limits conductance to less than 0.5 BTU per hour per square foot per degree Fahrenheit (R value = 2.0). There shall be no holes or other openings in the insulation or between the insulation and the RCC that allows outside air to penetrate the insulation. All steel protruding from the insulated RCC shall also be insulated. The insulation mats or blankets shall be tightly laced together or shall be overlapped by at least 2-feet at the seams and weighted or pinned to the RCC so that no RCC surface becomes exposed regardless of wind, rain or other conditions.

3.9.4 Hot-Weather Protection

When ambient air temperatures exceeds 90 degrees F and as soon as the conventional concrete and RCC is sufficiently hard to withstand washing of surface mortar, water by fog spraying shall be applied in a controlled manner to provide evaporative cooling. Water shall be applied at such a rate that it quickly evaporates and is subsequently rewetted such that the surface remains continuously moist without ponding. In addition, when surface materials begin to dry and while the RCC placement, spreading, and compaction process is still underway and until the concrete has sufficiently hardened to permit the above water spray, hand-held fog spraying shall be applied to the concrete surfaces as directed to prevent drying out of concrete materials and replace moisture lost to evaporation. These hot-weather protection procedures will require additional laborer(s) to assure complete coverage of the entire surface areas to prevent unacceptable damage to the RCC and conventional concrete.

3.9.5 Thermal Monitoring

Thermal monitoring of RCC monoliths shall be in accordance with section 013504 VIBRARING WIRE STRAIN GAGES/THERMISTORS. The thermal monitoring gages shall be located as shown on the drawings.

3.10 QUALITY CONTROL TESTING AND INSPECTION REQUIREMENTS

3.10.1 General

a. The Contractor shall perform the tests and inspections and based upon the results of these tests, he shall take corrective action and submit quality control reports as described below. In addition, results of quality control testing and inspections shall be reported separately and expeditiously. When, in the opinion of the Contracting Officer, the RCC operation is out of control, placement shall cease.

b. The laboratory performing the tests shall be on-site and shall conform with the requirements of ASTM C 1077. The individuals who sample and test concrete or the constituents of concrete as required in this specification shall have ACI certification for Concrete Field Testing Technician - Grade I and ACI Concrete Laboratory Testing Technician - Grade I. The individuals who perform quality control inspections of RCC shall have demonstrated a minimum of 10 years experience in like construction and knowledge, and have experience equivalent to ACI Concrete Transportation Construction Inspector. Additionally, the Contractor's superintendent for RCC construction shall demonstrate a minimum of 10 years of like experience.

c. QC Laboratory Inspection. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C 1077.

d. Informal Reports. All results of tests and inspections conducted shall be reported informally as they are completed and in writing daily. A weekly summary report shall be prepared covering the entire period from the start of the construction season through the current week. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in following paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all contractor quality control records.

e. Testing of aggregates, specified in paragraph 2.1, shall be done during the production and transportation of aggregates. Additional testing of aggregates specified below is to confirm aggregate quality prior to production of RCC.

3.10.2 Fine Aggregate Grading

a. Grading - At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C 136, ASTM C 117, and CRD-C 104 for the fine aggregate or for each fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control and as close to the mixer as possible. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits. The results shall be recorded on a sheet on which are also shown the specification limits applicable to the project.

b. Fineness-Modulus Control Chart - Results for fineness modulus shall be grouped in sets of three consecutive tests, and the average and range of each group shall be plotted on a control chart. The upper and lower control limits for average shall be drawn 0.10 units above and below the target fineness modulus, and the upper control limit for range shall be 0.20.

c. Corrective Action for Fine Aggregate Grading - When the amount passing on any sieve is outside the specification limits, the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately be reported to the Contracting Officer. Whenever a point on the fineness modulus control chart, either for average or range, is beyond one of the control limits, the frequency of testing shall be doubled. If two consecutive points are beyond the control limits, the process shall be considered out of control and concreting shall be stopped. The Contracting Officer shall be notified, and immediate steps shall be taken to rectify the situation. After two consecutive points have fallen within the control limits, testing at the normal frequency may be resumed.

3.10.3 Fine Aggregate Moisture Content

a. Moisture Content Testing - When in the opinion of the Contracting Officer the electric moisture meter is not operating satisfactorily, there shall be at least four tests for moisture content in accordance with ASTM C 566 during each 8-hour period of mixing plant operation. The times for the tests shall be selected randomly within the 8-hour period. An additional test shall be made whenever excessive variation in workability is reported by the placing foreman. When an electric moisture meter is operating satisfactorily, at least one direct measurement of moisture content shall be made per day to check the calibration of the meter. The results of tests for moisture content shall be used to adjust the added water in the control of the batch plant.

b. Moisture Content Corrective Action - Whenever the moisture content of the fine aggregate changes by 0.5 percent or more from the previous sample, the Contractor shall adjust mixture proportions to compensate for changes in aggregate moisture content.

3.10.4 Coarse Aggregate Grading

a. Grading - At least once during each shift in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. The Contractor may adopt limits for control coarser than the specification limits for samples taken other than as delivered to the mixer to allow for degradation during handling. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests inclu
ding the current test.

b. Corrective Action for Grading - When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of five tests are outside specification limits, the operation shall be considered out of control, and that fact shall be reported to the Contracting Officer, concreting shall be stopped, and immediate steps shall be taken to correct the grading.

3.10.5 Coarse Aggregate Moisture Content

a. Moisture Content Testing - A test for moisture content of each size group of coarse aggregate shall be made at least three times per week. When two consecutive readings for any size of coarse aggregate differ by more than 1.0 percent, frequency of testing shall be increased to that specified previously for fine aggregate.

b. Moisture Corrective Action - Whenever the moisture content of any size of coarse aggregate changes by 0.5 percent or more from the previous sample, the Contractor shall adjust mixture proportions to compensate for changes in aggregate moisture content.

3.10.6 Coarse Aggregate Fines Content

a. Material Finer than the 75 µm (No. 200) Sieve - When in the opinion of the Contracting Officer, a problem exists in connection with the cleanliness of the coarse aggregate, tests shall be made in accordance with ASTM C 117. Testing frequency shall be as directed.

b. Corrective Action for material finer than the 75 µm (No. 200) Sieve - When material finer than the No. 200 sieve exceeds 1.0 percent of the weight of the coarse aggregate finer than 37.5 mm (1-1/2 inch) or 0.5 percent of the weight of the aggregate coarser than 37.5 mm (1-1/2 inch), the Contracting Officer shall be notified, and steps, shall be initiated immediately.

3.10.7 Quality of Aggregates

a. Quality of Aggregates - Prior to submitting samples for mixture proportioning studies, the Contractor shall perform tests for aggregate quality as described in SECTION 03300.

b. Corrective Action for Aggregate Quality - If the result of a quality test fails to meet the requirements for quality during submittal of samples for mixture-proportioning studies or immediately prior to start of concrete placement, production procedures or materials shall be changed and additional tests shall be performed until the material meets the quality requirements prior to proceeding with either mixture-proportioning studies or starting concrete placement. After concrete placement commences, whenever the result of a test for quality fails the requirements, the test shall be rerun immediately. If the second test fails the quality requirement, the fact shall be reported to the Contracting Officer and immediate steps taken to rectify the situation.

3.10.8 RCC Plant Scales

a. Weighing Accuracy - The accuracy of the scales or other weighing devices shall be checked by test weights prior to start-up of concreting operations and at least once a month thereafter for conformance with the requirements of paragraphs 3.1.2.2 and 3.1.3.5. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could be attributed to weighing errors.

b. Scales Corrective Action - When the weighing accuracy does not comply with specification requirements, the plant shall not be operated until necessary adjustments or repairs have been made. Discrepancies in recording accuracy shall be corrected immediately.

3.10.9 Continuous Feed Calibrations

a. Feed Accuracy - The accuracy of continuous feeds shall be checked by both of the following methods:

(1) The weight of all materials corresponding to a standard time interval, and the resulting proportions of materials per cubic yard shall be determined. The accuracy of continuous feeds shall be determined at least three times prior to RCC production and placement. After the start of RCC production, rechecks shall be made at least every 10 shifts of operation and whenever there are variations in properties of the fresh concrete that could be attributed to continuous feed errors. The sample shall be of sufficient size to give accurate determinations and calibration may require weights in excess of 500 pounds per item checked.

(2) Cement and pozzolan feed rates shall be checked every 2 shifts of production. Cement feed rate shall be determined by operating the plant and discharging a volume of cement equivalent to 20 seconds or more plant time.

(3) The quantity of cement and pozzolan, determined from haul slips and silo levels, shall be determined for each shift of RCC produced.

b. Feeds Corrective Action - Whenever the volumetric or mass feed of materials (from (1), (2), or (3) is found to be out of compliance with specification requirements, the plant shall not be operated until the necessary adjustments or repairs have been made and the plant has been recalibrated.

3.10.10 RCC Mixer Performance

a. Mixer Performance Testing - A complete mixer performance test shall be made on each mixer in accordance with CRD-C 55 as modified by this specification prior to the start of RCC placing, reference paragraph 3.1.2.3. Additional tests may be performed at any time to support a Contractor's request for reducing mixing time. Up to two additional tests may be directed by the Contracting Officer to be performed during the period of RCC production.

b. Mixer Performance Corrective Action - If a mixer fails to meet the specified requirements, RCC production shall not be allowed to start or continue until the problem has been corrected. Whenever adjustments to a mixer are necessary because of a failure to meet uniformity requirements, the mixer shall be retested after adjustments.

3.10.11 Temperature Recording

a. Temperature Measurement - At least one test for RCC temperature shall be made at the mixing plant and at the placement site on randomly selected samples of RCC during each shift of placement. The ambient air temperature at each location shall also be recorded. The temperature test shall be performed in accordance with ASTM C 1064. Additional tests shall be made when rapid set time or unusual loss of workability is reported by the placing foreman or Government Inspector, or when cold or hot weather problems occur. The temperature of air and RCC shall be recorded during the period of cure and cold weather protection when those restrictions are applicable.

b. Action Required - Whenever the mix temperature falls below 40-degrees F or is above 75-degrees F, the Contractor shall notify the Contracting Officer immediately. All measured temperatures shall be included as standard data in the quality control reports.

3.10.12 RCC Moisture Content

a. Moisture Content Testing - The oven dry moisture content of the RCC shall be determined on the RCC at least once per shift in accordance with procedures described in ASTM C 566. The report shall also include the current mix proportions and plant settings that represent the material sampled. Additionally, correlation shall be made with microwave and hot plate drying methods. The Contracting Officer may request one additional test per shift using either convection oven, microwave or hot plate.

b. Action Required - The Contractor shall notify the Contracting Officer immediately if the moisture content is outside the designated range. All measured moisture contents shall be included as standard data in the quality control reports.

3.10.13 RCC Density

a. Nuclear Density Testing - Density shall be determined for at least 8 locations per lift of RCC. For larger lifts one density test shall be performed for at least every 2000 square feet of lift suface. Tests shall be performed using a calibrated nuclear density gauge in accordance with ASTM C 1040. Density shall be measured at depths of 4, 12, and 20-inches. Acceptance will be made at the 20-inch depth.

b. Action Required - Whenever the nuclear gauge indicates density less than the specified density, a retest shall be made. If the retest indicates unacceptable density, the Contracting Officer's Representative shall be notified and additional passes of the vibratory roller shall be provided. A determination shall be made as to weather the lower density resulted from insufficient passes of the roller, changes in the mix properties or changes in placement processes. If the lower density is the result of incomplete rolling, the operator shall be immediately notified and the rolling pattern adjusted. If the mix properties have changed, adjustments such as increasing or decreasing the moisture content shall be made at the batch plant. If the problem persists, the Contracting Officer may adjust the mix proportions of aggregate, cement, pozzolan or admixture. If placement processes such as time of compaction have changed, the Contraction shall make the necessary adjustments to transporting, spreading and compaction procedures to assure RCC is placed and consolidated within the specified timeframes. The Contracting Officer may require removal of the partially compacted material
at no cost to the Government.

3.10.14 RCC Vebe Consistency

a. Vebe Testing - The consistency of RCC shall be determined using the Vebe apparatus in accordance with CRD-C 53. The Vebe consistency shall be determined at least every 4 hours that RCC is placed. The frequency may be adjusted as determined by the Contracting Officer.

b. Action required - When the Vebe consistency time is outside of the specified range, the Contracting Officer shall be notified. Adjustments to the moisture content of the RCC may be required. Vebe consistency of the RCC shall be included as standard data in the quality control reports.

3.10.15 RCC Unit Weight

a. Unit Weight Testing - For each Vebe consistency test, the unit weight of the RCC shall be determined using the cylindrical Vebe mold or the bowl of a Type B air pressure meter (ASTM C 231). The unit weight test shall be performed in general accordance with ASTM C 138, modified using external vibration of the Vebe table and a nominal 10 pound surcharge steel consolidation tamper to consolidate the RCC.

b. Action Required - Whenever unit weight tests are determined to be outside the specified range, the Contractor shall immediately notify the Government Inspector. Unit weight shall be included as standard data in the quality control reports.

3.10.16 RCC Air Content

a. Air Content Testing - Air content of the RCC shall be determined at least once every two shifts of RCC placement. The air content shall be performed in general accordance with ASTM C 231 using a Type B air meter. The procedure shall be modified using external vibration of the Vebe table and a nominal 10-pound surcharge steel consolidation tamper to consolidate the RCC in the air meter bowl.

b. Action Required - Whenever an air content test is determined to be outside the specified range, the Contractor shall immediately retest and notify the Government Inspector. Air content of the RCC shall be included as standard data in the quality control reports.

3.10.17 RCC Compressive Strength

a. Compressive Strength Testing - A set of seven nominal 6x12-inch compressive strength cylinders shall be cast for at least every shift of RCC placement. Cylinders shall be consolidated in four layers using external vibration of the Vebe table and a nominal 10 pound surcharge steel consolidation tamper to consolidate the RCC in disposable plastic cylinder molds. Cylinders shall be standard moist cured in accordance with ASTM C 31 and tested for compressive strength in accordance with ASTM C 39. Two compressive strength tests each shall be made at the ages 7, 28, and 90 days. One additional test shall be performed at the test age of 365 days.

b. Action Required - Whenever a compressive strength is below the specified minimum, the Contractor shall immediately notify the Government Inspector. Compressive strength tests shall be included as standard data in the quality control reports.

3.10.18 Bedding Mortar Slump

a. Bedding Mortar Slump Testing - At least two slump tests shall be made in accordance with ASTM C 143 on bedding mortar produced during each 8-hour period or less of concrete production each day. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. The result of each test for each mixture shall be plotted on a control chart on which the upper and lower limits are set as specified in paragraph 2.2.1. The range shall be plotted on a control chart on which the upper control limit is 2.0 inches.
Samples for slump shall be taken at the mixer, however the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or trans
portation methods cause slump loss between the mixer and the placement, samples shall be taken at the placement site as often as required by the Contracting Officer.

b. Slump Corrective Action - When a single slump is outside the upper or lower control limits, an adjustment shall be made in the mixture proportions. The adjustments are to be made so that the total water:cementitious material content by weight does not exceed that amount specified in the mixture proportions provided by the Contracting Officer. As soon as practical after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive individual slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range above the upper control limits, the slump shall be considered to be out of control, the concreting operation halted, and the additional testing for aggregate moisture content required shall be undertaken, and action taken immediately to correct the problem.

3.10.19 Bedding Mortar Compressive Strength

a. Compressive Strength Testing - A set of seven nominal 3x6-inch compressive strength cylinders shall be cast for at least every shift of RCC placement. Cylinders shall be made and standard moist cured in accordance with ASTM C 31. Two compressive strength tests shall be made in accordance with ASTM C 39 at ages 7, 28, and 90 days, and one hold cylinder.

b. Action Required - Whenever a compressive strength is below the specified minimum, the Contractor shall immediately notify the Government Inspector. Compressive strength tests on bedding mortar shall be included as standard data in the quality control reports.

3.10.20 Concrete Plant Control

The measurement of all constituent materials including cementitious materials, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate weights and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. A shift report shall be prepared indicating type and source of cement used, type and source of pozzolan used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic yard, amount of water as free moisture in each size of aggregate, and the as-mixed aggregate and water weights per cubic yard for each type of concrete placed during plant operation.

3.10.21 RCC Placing Inspection

a. Inspection - The Contractor shall provide full time supervision of all placing operations to insure that the correct quality of RCC, conventional concrete, or bedding mortar is placed in each location and that all other aspects of the placing operation are performed in accordance with the contract. During placing operations, the quality control staff shall measure and record concrete temperatures in accordance with ASTM C 1064, ambient temperature hourly, record weather conditions, time of placement, yardage placed, and method of placement.

b. Corrective Action - The placing foreman shall not permit placing to begin until he has verified that an adequate number of vibrators, spreaders, and compactors in working order and with competent operators are available. Placing shall not be continued if any conventional concrete is inadequately consolidated, if any lift of RCC is not fully compacted, or if any concrete is not consolidated within the specified time. Additional compaction, if necessary, shall be performed in accordance with paragraph 3.5. If any batch of conventional concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

3.10.22 Vibrators

a. Vibrator Testing and Use - The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made as directed when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined while the vibrator is operating in concrete with the tachometer being held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head, and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing.

b. In addition, the self-propelled vibratory rollers, as specified in paragraph 3.5.2.1, shall be checked for frequency and amplitude prior to use and once every 1-month when RCC is being placed.

c. Vibrator Corrective Action - Any vibrator not meeting the requirements of paragraph 3.5.4 shall be immediately removed from service and repaired or replaced.

3.10.23 Compaction Equipment

a. Compaction Equipment Checks - Any compactor for use in RCC construction shall be checked to assure correct dimensions, weight, and vibratory capacity prior to use. At least, once every 10 shifts of use, a recheck of frequency and vibratory controls shall be made. During the first five days of operation the performance of all operators shall be checked to assure that the correct number of passes, full coverage and good rolling practice are provided. Thereafter performance checks shall be made weekly.

b. Action Required - Compaction equipment not meeting the specified physical requirements shall be removed from the project. Any roller having the improper frequency or amplitude settings shall be corrected before being used for RCC compaction. Roller operators that use excessive speed, do not provide sufficient coverage or roller passes, or that otherwise do not use good rolling practice shall be immediately notified. Cited operators shall take immediate corrective action or be replaced. Checks on compaction equipment and shall be included in the quality control reports.

3.10.24 Curing Inspection

a. Moist Curing Inspections - At least twice each shift, and twice per day on nonwork days an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.

b. Moist Curing Corrective Action - When a daily inspection report lists an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for those areas shall be extended by one day. Any deficiency that is noted shall be immediately reported to the Government Inspector. Results of curing inspections shall be included in the quality control reports.

3.10.25 Cold and Hot-Weather Protection

a. Cold and Hot Weather Protection - At least once each shift and once per day on non-work days an inspection shall be made of all areas subject to cold-weather or hot-weather protection. Any deficiencies shall be noted, corrected, and reported. During periods of cold weather and hot weather, pertinent temperatures shall be recorded at least once per 2 hours and reported daily.

b. Action Required - When a daily inspection report lists deficiencies, the deficiency shall be corrected immediately and the period of protection extended for one day. Any deficiency that is noted shall be immediately reported to the Government Inspector. Results of cold and hot-weather protection inspections shall be included in the quality control reports.

3.10.26 Control Charts

The Contractor shall maintain control charts for the test parameters listed below. Each chart shall present cumulative raw data, cumulative average of data, last 5 moving average, and last 20 moving average for each parameter as well as control lines and cutoff lines. Graphic representations of all control charts shall be posted in a location designated by the Contracting Officer. In addition, data as Excel spreadsheet files suitable for PC-DOS compatible equipment, shall be submitted to the Contracting Officer daily. A control chart shall be maintained for each of the following tests:

(1) RCC wet density at 12 inches depth

(2) RCC OCD maximums at 12 inches depth

(3) Aggregate percent passing during aggregate production and RCC placement for each of the following sieves; 2-inch, 3/4-inch, No. 4, No. 30, and No. 200.

(4) RCC vebe times

(5) RCC unit weight

(6) RCC moisture content

(7) Bedding mortar slump

(8) RCC Compressive Strength

(9) Bedding Mortar Compressive Strength

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METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS
12/92

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ALUMINUM ASSOCIATION (AA)

AA DESIGN MANUAL	(2000) Aluminum Design Manual: Specification & Guidelines for Aluminum Structures

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(2001a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 325	(2001) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 380	(1999e1) Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems
ASTM A 490	(2002) Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
ASTM A 514/A 514M	(2000a) High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM B 117	(1997) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B 177	(2001) Chromium Electroplating on Steel for Engineering Use
ASTM D 962	(1981; R 1999) Aluminum Powder and Paste Pigments for Paints
ASTM D 2509	(1993; R 1998) Standard Test Method for Measurement of Load-Carrying Capacity of Lubricating Grease (Timken Method)
ASTM E 94	(2000) Radiographic Testing

ASTM E 165	(1995) Liquid Penetrant Examination Inspection Method
ASTM E 446	(1998) Radiographs for Steel Casting up to 2 in. (51 mm) in Thickness
ASTM E 709	(2001) Magnetic Particle Examination
ASTM F 593	(2001) Stainless Steel Bolts, Hex Cap Screws and Studs
ASTM F 594	(2001) Stainless Steel Nuts
ASTM F 879	(2001) Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws

ASME INTERNATIONAL (ASME)

ASME B4.1	(1967; R 1999) Preferred Limits and Fits for Cylindrical Parts
ASME B46.1	(1995) Surface Texture (Surface Roughness, Waviness, and Lay)
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME Y14.5M	(1994 R: 1999) Dimensioning and Tolerancing

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(2001) Structural Welding Code - Steel
AWS D1.2	(1997) Structural Welding Code - Aluminum
AWS D1.5	(1996) Bridge Welding Code
AWS D1.6	(1999) Structural Welding Code-Stainless Steel

MILITARY SPECIFICATIONS (MS)

MS MIL-P-21035	(1991; Rev B)Paint High Zinc Dust Content,Galvanizing Repair

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE AMS 3110	(2001; Rev H) Primer Zinc Chromate
SAE AMS 3132	(2001; Rev G) Varnish, Phenolic Resin

Corrosion-Preventive

1.2 PAYMENT

No separate payment or direct payment will be made for the work covered under this section. Any such work shall be included in the applicable bid item to which the work pertains.

1.3 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-04 Drawings

Detail Drawings; GA,ED.

Detail drawings for metalwork and machine work shall be submitted and approved prior to fabrication.

SD-06 Instructions

Bearing and Bushing Specifications; GA, ED.

Manufacturer specified running clearance and interference fit tolerances for bearing and bushings shall be submitted prior to manufacture components in which they are used and installation of the bearings and bushings.

SD-07 Schedules

Materials Orders; FIO.

Copies of purchase orders, mill orders, shop orders, and work orders for materials shall be submitted prior to the use of the materials in the work.

Materials List; FIO.

Materials list for fabricated items shall be submitted at the time of submittal of detail drawings.

Shipping Bill; FIO.

Shipping bill shall be submitted with the delivery of finished pieces to the site.

SD-08 Statements

Welding Procedures for Structural Steel; GA, RE.

Schedules of welding procedures for steel structures shall be submitted and approved prior to commencing fabrication.

Welding Procedures for Stainless Steel; GA, RE.

Schedules of welding procedures for stainless steel structures shall be submitted and approved prior to commencing fabrication.

Welding of Aluminum; GA, ED.

Schedules of welding processes for aluminum fabrications shall be submitted and approved prior to commencing fabrication.

Structural Steel Welding Repairs; GA, ED.

Welding repair plans for steel shall be submitted and approved prior to making repairs.

Stainless Steel Welding Repairs; GA, RE.

Welding repair plans for stainless steel shall be submitted and approved prior to making repairs.

SD-09 Reports

Tests, Inspections, and Verifications; FIO.

Certified test reports for materials shall be submitted with all materials delivered to the site.

SD-13 Certificates

Qualification of Welders and Welding Operators; GA, RE.

Certifications for welders and welding operators shall be submitted prior to commencing fabrication.

Application Qualification for Steel Studs; GA, ED.

Certified reports for the application qualification for steel studs shall be submitted and approved prior to commencing fabrication.

Welding of Aluminum; GA, ED.

Certified report for aluminum welding qualification tests shall be submitted and approved prior to commencing welding.

Threaded Fastener Certifications; FIO.

Manufacturer certification shall be provided prior to commencing fabrication. Documentation shall show threaded fastener meet the specified requirements.

SD-18 Records

Materials Disposition Records; FIO.

Materials disposition records shall be submitted before completion of contract.

1.4 METALWORK AND MACHINE WORK DETAIL DRAWINGS

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Detail drawings for metalwork and machine work shall include catalog cuts, templates, fabrication and assembly details, and type, grade and class of material as appropriate. **Each Detail Drawing shall be identified as metal work or as machine work.** Elements of fabricated items inadvertently omitted on contract drawings shall be detailed by the fabricator and indicated on the detail drawings.

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1.5 QUALIFICATION OF WELDERS AND WELDING OPERATORS

The Contractor shall certify that the qualification of welders and welding operators and tack welders who will perform structural steel welding have been qualified for the particular type of work to be done in accordance with the requirements of AWS D1.1, Section 5, AWS D1.5, Section 5 (for miter gates), AWS D1.6, Sections 4&7, prior to commencing fabrication or ASME BPV IX, Section IX, prior to commencing fabrication. The certificate shall list the qualified welders by name and shall specify the code and procedures under which qualified and the date of qualification. Prior qualification will be accepted if welders have performed satisfactory work under the code for which qualified within the preceding three months. The Contractor shall require welders to repeat the qualifying tests when their work indicates a reasonable doubt as to proficiency. Those passing the requalification tests will be recertified. Those not passing will be disqualified until passing. All expenses in connection with qualification and requalification shall be borne by the Contractor.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Materials Orders

The Contractor shall furnish three copies of purchase orders, mill orders, shop orders, and work orders for all materials orders and items used in the work. Where mill tests are required, purchase orders shall contain the test site address and the name of the testing agency.

2.1.2 Materials List

The Contractor shall furnish a materials list of the materials to be used in the fabrication of each item.

2.1.3 Shipping Bill

The Contractor shall furnish a shipping bill or memorandum of each shipment of finished pieces or members to the project site giving the designation mark and weight of each item, the number of items, the total weight, and the car initial and number if shipped by rail in carload lots. Duplicate copies of shipping bills shall be mailed promptly to

Louisville Resident Office
2750 Marine Street
Louisville, KY 40212
Attn: Resident Engineer.

2.2 FABRICATION

All items covered by this specification section that are part of a larger system or in themselves form an adjustable or operable assembly shall be finished machined in accordance with the paragraph titled MACHINE WORK. This includes all pins, shafts, axles, trunnions, rollers, bearings, bushings, adjustable quoin and miter quoin block assemblies, embedded wall quoin, gate latching devices, hydraulic cylinder support brackets, bearing housings, gudgeon anchor assemblies, clevis and eye connections and pintle assemblies. Items included with the previous but not explicitly named are plates and castings that are to be drilled, bored, punched or otherwise manipulated to interface with bearings, bushings, pins, shafts or axles. Additional items so indicated on the contract drawings with dimensional tolerances shall also be fabricated as specified in the paragraph titled MACHINE WORK.

2.2.1 Structural Fabrication

Material must be straight before being laid off or worked. If straightening is necessary it shall be done by methods that will not impair the metal. Sharp kinks or bends shall be cause for rejection of the material. Material with welds will not be accepted except where welding is definitely specified, indicated, or otherwise approved. Bends shall be made by approved dies, press brakes, or bending rolls. Where heating is required, precautions shall be taken to avoid overheating the metal and it shall be allowed to cool in a manner that will not impair the original properties of the metal. Proposed flame cutting of material other than structural steel shall be subject to approval and shall be indicated on detail drawings. Shearing shall be accurate and all portions of the work shall be neatly finished. Corners shall be square and true unless otherwise shown. Re-entrant cuts shall be filleted to a minimum radius of 3/4 inch unless otherwise approved. Finished members shall be free of twists, bends and open joints. Bolts, nuts and screws shall be tight.

2.2.1.1 Dimensional Tolerances for Structural Work

Dimensions shall be measured by an approved calibrated steel tape of approximately the same temperature as the material being measured. The overall dimensions of an assembled structural unit shall be within the tolerances indicated on the drawings or as specified in the particular section of these specifications for the item of work. Where tolerances are not specified in other sections of these specifications or shown, an allowable variation of1/32 inch is permissible in the overall length of component members with both ends milled and component members without milled ends shall not deviate from the dimensions shown by not more than 1/16 inch for members30 feet or less in length and by more than 1/8 inch for members over30 feet in length.

2.2.1.2 Structural Steel Fabrication

Structural steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a surface that is smooth and free from cracks and notches is obtained. Surfaces and edges to be welded shall be prepared in accordance with AWS D1.1, Subsection 3.2 with the exception of the miter gates which shall be prepared in accordance with AWS D1.5, Section 3.2. Where structural steel is not to be welded, chipping or grinding will not be required except as necessary to remove slag and sharp edges of mechanically guided or hand-guided cuts not exposed to view. Hand-guided cuts which are to be exposed or visible shall be chipped, ground or machined to sound metal.

2.2.1.3 Structural Aluminum Fabrication

Laying out and cutting of aluminum shall be in accordance with the AA DESIGN MANUAL.

2.2.2 Welding

2.2.2.1 Welding of Structural Steel

a. Welding Procedures for Structural Steel - Welding procedures for structural steel shall be prequalified as described in AWS D1.1, Subsection 5.1 or shall be qualified by tests as prescribed in AWS D1.1, Section 5 and, likewise, the miter gates welds shall be prequalified per AWS D1.5. Properly documented evidence of compliance with all requirements of these specifications for previous qualification tests shall establish a welding procedure as prequalified. For welding procedures qualified by tests, the test welding and specimen testing must be witnessed and the test report document signed by the Contracting Officer. Approval of any welding procedure will not relieve the Contractor of the responsibility for producing a finished structure meeting all requirements of these specifications. The Contractor will be directed or authorized to make any changes in previously approved welding procedures that are deemed necessary or desirable by the Contractor Officer. The Contractor shall submit a complete schedule of welding procedures for each steel structure to be welded. The schedule shall conform to the requirements specified in the provisions AWS D1.1 , Sections 2, 3, 4, 7 and 9 and applicable provisions of Section 10 or AWS D1.5 for the miter gates. The schedule shall provide detailed procedure specifications and tables or diagrams showing the procedures to be used for each required joint. Welding procedures must include filler metal, preheat, interpass temperature, and stress-relief heat treatment requirements. Each welding procedure shall be clearly identified as being prequalified or required to be qualified by tests. Welding procedures must show types and locations of welds designated or in the specifications to receive nondestructive examination. All joints shall receive a continuous seal weld, unless otherwise noted on the drawing.

b. Welding Process - Welding of structural steel shall be by an electric arc welding process using a method which excludes the atmosphere from the molten metal and shall conform to the applicable provisions of AWS D1.1, Sections 1 thru 7, 9, 10 and 11 or AWS D1.5 for the miter gates. Welding shall be such as to minimize residual stresses, distortion and shrinkage.

c. Welding Technique

(1) Filler Metal - The electrode, electrode-flux combination and grade of weld metal shall conform to the appropriate AWS specification for the base metal and welding process being used or shall be as shown where a specific choice of AWS specification allowables is required. The AWS designation of the electrodes to be used shall be included in the schedule of welding procedures. Only low hydrogen electrodes shall be used for manual shielded metal-arc welding regardless of the thickness of the steel. A controlled temperature storage oven shall be used at the job site as prescribed by AWS D1.1, Subsection 4.5 to maintain low moisture of low hydrogen electrodes.

(2) Preheat and Interpass Temperature - Preheating shall be performed as required by AWS D1.1or AWS D1.5 (for miter gates0 Subsections 4.2 and 4.3 or as otherwise specified except that the temperature of the base metal shall be at least 70 degrees F. The weldments to be preheated shall be slowly and uniformly heated by approved means to the prescribed temperature, held at that temperature until the welding is completed, and then permitted to cool slowly in still air.

(3) Stress-Relief Heat Treatment - Where stress relief heat treatment is specified or shown, it shall be in accordance with the requirements of AWS D1.1 or AWS D1.5 (for miter gates) Subsection 4.4 unless otherwise authorized or directed.

d. Workmanship - Workmanship for welding shall be in accordance with AWS D1.1, Section 3 or AWS D1.5, Section 3 for miter gates. other applicable requirements of these specifications.

(1) Preparation of Base Metal - Prior to welding the Contractor shall inspect surfaces to be welded to assure compliance with AWS D1.1, Subsection 3.2 or AWS D1.5, Subsection 3.2. for the miter gates.

(2) Temporary Welds - Temporary welds required for fabrication and erection shall be made under the controlled conditions prescribed for permanent work. Temporary welds shall be made using low-hydrogen welding electrodes and by welders qualified for permanent work as specified in these specifications. Preheating for temporary welds shall be as required by AWS D1.1 or AWS D1.5 (miter gates) for permanent welds except that the minimum temperature shall be 120 degrees F in any case. In making temporary welds arcs shall not be struck in other than weld locations. Each temporary weld shall be removed and ground flush with adjacent surfaces after serving its purpose.

(3) Tack Welds - Tacks welds that are to be incorporated into the

permanent work shall be subject to the same quality requirements as the permanent welds and shall be cleaned and thoroughly fused with permanent welds. Preheating shall be performed as specified above for temporary welds. Multiple-pass tack welds shall have cascaded ends. Defective tack welds shall be removed before permanent welding.

2.2.2.2 Welding of Stainless Steel

a. Welding Procedures for Stainless Steel - Welding procedures for stainless steel shall be prequalified as described in AWS D1.6, Subsection 3 or shall be qualified by tests as prescribed in AWS D1.6, Section 4 and for stainless steel studs shall be as prescribed in AWS D1.6 section 7. Properly documented evidence of compliance with all requirements of these specifications for previous qualification tests shall establish a welding procedure as prequalified. For welding procedures qualified by tests, the test welding and specimen testing must be witnessed and the test report document signed by the Contracting Officer. Approval of any welding procedure will not relieve the Contractor of the responsibility for producing a finished structure meeting all requirements of these specifications. The Contractor will be directed or authorized to make any changes in previously approved welding procedures that are deemed necessary or desirable by the Contractor Officer. The Contractor shall submit a complete schedule of welding procedures for each steel structure to be welded. The schedule shall conform to the requirements specified in the provisions AWS D1.6, Sections 2, 3, 4, 5 and 7. The schedule shall provide detailed procedure specifications and tables or diagrams showing the procedures to be used for each required joint. Welding procedures must include filler metal, preheat, interpass temperature and stress-relief heat treatment requirements. Each welding procedure shall be clearly identified as being prequalified or required to be qualified by tests. Welding procedures must show types and locations of welds designated or in the specifications to receive nondestructive examination.

b. Welding Process - Welding of stainless steel shall be by an electric arc welding process using a method which excludes the atmosphere from the molten metal and shall conform to the applicable provisions of AWS D1.6, Sections 1 thru 5. Welding for stainless steel studs shall be by an automatic welding machine or an electric arc welding process that excludes the atmosphere from the molten metal and shall conform the the applicable provisions of AWS D1.6 Subsection 7.5 .Welding shall be such as to minimize residual stresses, distortion and shrinkage.

c. Welding Technique

(1) Filler Metal - The electrode, electrode-flux combination and grade of weld metal shall conform to the appropriate AWS specification for the base metal and welding process being used or shall be as shown where a specific choice of AWS specification allowables is required. The AWS designation of the electrodes to be used shall be included in the schedule of welding procedures.

Handling, storage and certification of electrodes AWS D1.6, Subsection 5.1.4.

(2) Preheat and Interpass Temperature - Preheating shall be performed as required by AWS D1.6, Subsection 4.2 and 4.3 or as otherwise specified except that the temperature of the base metal shall be at least 70 degrees F. The weldments to be preheated shall be slowly and uniformly heated by approved means to the prescribed temperature, held at that temperature until the welding is completed and then permitted to cool slowly in still air.

(3) Stress-Relief Heat Treatment - Where stress relief heat treatment is specified or shown, it shall be in accordance with the requirements of AWS D1.6, Subsection 4.4 unless otherwise authorized or directed.

d. Workmanship - Workmanship for welding shall be in accordance with AWS D1.6, Section 3 and Subsection 7.4 and other applicable requirements of these specifications.

(1) Preparation of Base Metal - Prior to welding the Contractor shall inspect surfaces to be welded to assure compliance with AWS D1.6, Subsection 3.2 and Subsection 7.4.2.

(2) Temporary Welds - Temporary welds required for fabrication and erection shall be made under the controlled conditions prescribed for permanent work. Temporary welds shall be made using low-hydrogen welding electrodes and by welders qualified for permanent work as specified in these specifications. Preheating for temporary welds shall be as required by AWS D1.6 for permanent welds except that the minimum temperature shall be 120 degrees F in any case. In making temporary welds arcs shall not be struck in other than weld locations. Each temporary weld shall be removed and ground flush with adjacent surfaces after serving its purpose.

(3) Tack Welds - Tacks welds that are to be incorporated into the permanent work shall be subject to the same quality requirements as the permanent welds and shall be cleaned and thoroughly fused with permanent welds. Preheating shall be performed as specified above for temporary welds. Multiple-pass tack welds shall have cascaded ends. Defective tack welds shall be removed before permanent welding.

2.2.2.3 Welding of Steel Castings

Unsound material shall be removed from the surfaces of steel castings to be incorporated into welded connections by chipping, machining, air-arc gouging, or grinding. Major connections designed for transfer of stresses shall not be welded if the temperature of the casting is lower than 100 degrees F. Castings containing over 0.35 percent carbon or over 0.75 percent manganese shall be preheated to a temperature not to exceed 450 degrees F and welding shall be accomplished while the castings are maintained at a temperature above 350 degrees F. Welding will not be permitted on castings containing carbon in excess of 0.45 percent except on written authorization. Castings requiring welding repairs after the first annealing and castings involving welding fabrication shall be stress-relieved annealed prior to receiving final machining unless otherwise permitted.

2.2.2.4 Welding of Aluminum

Welding of aluminum shall conform to AA DESIGN MANUAL or AWS D1.2, Sections 1 through 7, 9 and 10. The welding process and welding operators shall be prequalified as required by AWS D1.2, Section 5 or AA DESIGN MANUAL ,in accordance with the methods described in ASME BPV IX, Section IX. A certified report giving the results of the qualifying tests shall be furnished for approval. A complete schedule of the welding process for each aluminum fabrication to be welded shall be furnished for approval.

2.2.2.5 Welding of Steel Studs

The procedures for welding steel studs to structural steel, including mechanical, workmanship, technique, stud application qualification, production quality control, and fabrication and verification inspection procedures shall conform to the requirements of AWS D1.1, Section 7, except as otherwise specified.

a. Application Qualification for Steel Studs - As a condition of approval of the stud application process, the Contractor shall furnish certified test reports and certification that the studs conform to the requirements of AWS D1.1, Subsections 7.2 and 7.3, certified results of the stud manufacturer's stud base qualification test, and certified results of the stud application qualification test as required by AWS D1.1, Subsection 7.6, except as otherwise specified. The test specimens shall be prepared using suitable specimen plates of the same base metal to which the studs are to be welded.

b. Production Quality Control - Quality control for production welding of studs shall conform to the requirements of AWS D1.1, Subsection 7.7, except as otherwise specified. Studs on which pre-production testing is to be performed shall be welded in the same general position as required on production studs (flat, vertical, overhead or sloping). If the reduction of the length of studs becomes less than normal as they are welded, welding shall be stopped immediately and not resumed until the cause has been corrected.

2.2.3 Threaded Connections

Unless specified elsewhere threaded fasteners of the types shown below will be provided for every threaded connection covered by the specification section. Threaded Fastener Certifications for each of the following shall be furnished to the Contracting Officer. Each certification shall show the items meet the requirements specified. Coat external threads of fasteners that will remain unpainted with anti-seize thread lubricant before assembling. Tighten bolts, nuts and hex head cap screw using the turn of the nut method unless indicated on the contract drawings or specified in a more applicable section of these project specifications. Tighten other threaded fastener until tight without damaging the fastener.

2.2.3.1 Threaded Structural Steel Connections

Bolts, nuts and washers shall be of the type specified or indicated. All nuts shall be equipped with washers except for high strength bolts. Beveled washers shall be used where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where the use of high strength bolts is specified or indicated the materials, workmanship and installation shall conform to the applicable provisions of ASTM A 325 or ASTM A 490.

a. Bolt Holes - Bolt holes shall be accurately located, smooth, perpendicular to the member, and cylindrical.

(1) Holes for regular bolts shall be drilled or subdrilled and reamed in the shop and shall not be more than 1/16 inch larger than the diameter of the bolt.

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(2) **Holes for turned bolts shall be match-reamed or drilled in the shop.** Burrs resulting from reaming shall be removed. The threads of bolts shall be entirely outside of the **shear plane**. The body diameter of bolts shall have tolerances as recommended by ASME B4.1for the class of fit specified. **Turned bolts shall have a class LC-1 fit.**.

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(3) Holes for high strength bolts shall have diameters of not more than 1/16 inch larger than bolt diameters. If the thickness of the material is not greater than the diameter of the bolts the holes may be punched. If the thickness of the material is greater than the diameter of the bolts the holes may be drilled full size or subpunched or subdrilled at least 1/8 inch smaller than the diameter of the bolts and then reamed to full size. Poor matching of holes will be cause for rejection. Drifting occurring during assembly shall not distort the metal or enlarge the holes. Reaming to a larger diameter of the next standard size bolt will be allowed for slight mismatching.

2.2.3.2 Threaded Stainless Steel Connections

Bolts shall be ASTM F 593 Group 4, 5 or 6. Nuts shall be ASTM F 594 Group 1, 2 or 3. Washers shall be of 300 series stainless steel. All bolt heads and nuts shall receive a washer. Each piece shall be American made.

Hex head cap screws shall be equipped with washers and shall be ASTM F 593 Group 4, 5 or 6. Washers shall be of 300 series stainless steel. Flat Countersunk Head Cap Screws shall be ASTM F 879. All hex head cap screws shall receive a washer. Each piece shall be American made.

a. Bolt Holes - Bolt holes shall be accurately located, smooth, perpendicular to the member, and cylindrical.

(1) Holes for regular bolts shall be drilled or subdrilled and reamed in the shop and shall not be more than 1/16 inch larger

than the diameter of the bolt.

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(2) **Holes for turned bolts shall be match-reamed or drilled in the shop.** Burrs resulting from reaming shall be removed. The threads of bolts shall be entirely outside of the **shear plane**. The body diameter of bolts shall have tolerances as recommended by ASME B4.1for the class of fit specified. **Turned bolts shall have LC-1 fit.**

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(3) Holes for high strength bolts shall have diameters of not more than 1/16 inch larger than bolt diameters. If the thickness of the material is not greater than the diameter of the bolts the holes may be punched. If the thickness of the material is greater than the diameter of the bolts the holes may be drilled full size or subpunched or subdrilled at least 1/8 inch smaller than the diameter of the bolts and then reamed to full size. Poor matching of holes will be cause for rejection. Drifting occurring during assembly shall not distort the metal or enlarge the holes. Reaming to a larger diameter of the next standard size bolt will be allowed for slight mismatching.

2.2.3.3 Threaded Aluminum Connections

Punching, drilling, reaming, and bolting for bolted aluminum connections shall conform to the requirements of AA DESIGN MANUAL.

2.2.3.4 Anti-Seize Thread Lubricant

For structural steel and stainless steel threaded fasteners thread lubricant shall be Loctite Corporation's Nickel Anti-Seize Lubricant, Product number 771 or approved equal. Anti-seize Thread lubricant shall consist of mineral oil, nickel, and graphite and be in paste form. It shall prevent galling of threads up to tempertures of 1400 deg F. The lubricant will be compatible with stainless and carbon steels. Anti-Seize thread lubricant shall prevent signs of corrosion for 168 hours of exposure to salt water spray in accordance with ASTM B 117. Wear resistance shall defined by a fail load of 7600 psi per ASTM D 2509. Friction coefficient shall be 0.10 when applied to bolt threads.

2.2.4 Patterns

Care shall be taken to avoid sharp corners or abrupt changes in cross section and ample fillets shall be used in the construction of patterns. Draft and increases in pattern thicknesses shall be added as required to conform to the standard foundry practice applied and as necessary to ensure that all metal thicknesses of the finished castings conform to the dimensions shown and are within the tolerances specified in paragraph INSPECTION OF STEEL CASTINGS. Patterns for those parts listed below shall be furnished by the Contractor, become the property of the Government and not be used for work under any other contract unless specifically authorized. All other patterns shall remain the property of the Contractor.

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MITER GATES

PART NUMBER	PART DESCRIPTION
MCA 230.3/S294-IR	Pintle Socket
MCA 230.3/S294-IL	Pintle Socket
MCA 230.3/S292-3	Pintle Bushing
MCA 230.3/S292-2	Pintle
MCA 230.3/S293-IR	Pintle Base
MCA 230.3/S293-IL	Pintle Base
MCA 230.3/S285-1	Cylinder Pin
MCA 230.3/S285-2	Cylinder Pin Bearing Housing

MITER GATES MACHINERY

PART NUMBER	PART DESCRIPTION
MCA 230.3/M28-1	Latch Device Mount
MCA 230.3/S28-2	Latch Device Insert

CULVERT VALVE

PART NUMBER	PART DESCRIPTION
MCA 220.1/S253-1	Trunnion Casting
MCA 220.1/M24-1	Strut Clevis
MCA 220.1/M24-2	Strut Eye
MCA 220.1/M24-3	Link Eye
MCA 220.1/M24-4	Cylinder Rod Clevis

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2.2.4.1 Fabrication of Patterns and Core Boxes

Patterns and core boxes that shall become the property of the Government shall be substantially made from thoroughly seasoned Grade B or better sugar pine, northern white pine or an approved equal. Built-up patterns and core boxes shall be securely glued and screwed together. Glue shall be of an approved high grade, water resistant, and suitably treated for resistance to fungus and insect infestation. Only light sections are permitted to be nailed. Screw holes shall be counter bored and neatly filled with wood plugs. Loose pieces shall be dovetailed or fastened with pull-out dowels. Split patterns and core boxes shall have metal dowels at partings. Skeleton or sweep patterns will not be accepted unless specifically authorized. All nail and tool marks on molding surfaces shall be filled with beeswax. All surfaces shall be sanded with No. 0 grade sandpaper. Patterns shall be finished with not less than three coats of an approved phenolic-resin sealer colored in accordance with the standard trade practices for pattern colors. Each pattern, core box and loose piece shall be stamped with the part mark shown. Patterns shall be furnished complete with necessary core boxes and templates.

2.2.4.2 Disposition of Patterns, Core Boxes, and Templates

Boxes and crates for the packing and shipment of patterns, core boxes, and templates shall be substantially made and put together with screws so that they can be used several times. Each box and crate shall be plainly marked to indicate its contents. All patterns, core boxes, and templates including those loaned to the Contractor by the Government used shall be thoroughly cleaned, crated, and delivered in first-class condition with a list of same in duplicate to U.S Army Corps of Engineers, Louisville Repair Station, before final payment is made. The Contracting Officer reserves the right to withhold payment for final parts made from any pattern until such pattern is delivered. Patterns and core boxes shall be varnished and all templates given a coat of an approved paint before being crated. Any pattern, core box, or template lost in shipment or damaged by the Contractor shall be replaced by the Contractor without charge to the Government.

2.2.5 Castings

Each casting shall bear cast or stamped mark numbers. Castings weighing more than 500 required pounds shall also bear cast or stamped heat numbers. Deviations from the dimensions of castings shown shall not exceed amounts that will impair the strength of castings by more than 10 percent as computed from the dimensions shown. Dimensions of castings shown on approved detail drawings shall be finished dimensions. Should these finished dimensions or wall thickness of casting differ from the contract plans the contractor is responsible for adjusting dimensions of interfacing parts, such as, mounting bolts, connecting pins, and bushings, for example. These changing dimensions shall be indicated on detail drawings and submitted for approval. Holes bored in castings shall be spot faced to provide the flatness requirements of paragraph titled MACHINE WORK. Additional machining of castings shall be in accordance with paragraph titled MACHINE WORK.

Castings that are warped or otherwise distorted or that are oversized to an extent that will interfere with proper fit with other parts of the machinery or structure will be rejected. The structure of metal in castings shall be homogeneous and free from excessive nonmetallic inclusions. Excessive segregation of impurities or alloys at critical points in castings will be cause for rejection. Repairs to castings shall not be made prior to approval. Minor surface imperfections not affecting the strength of casting may be welded in the "green" if approved. Surface imperfections shall be considered minor when the depth of the cavity prepared for welding is the lesser of 20 percent of the actual wall thickness or 1 inch. Defects other than minor surface imperfections may be welded only when specifically authorized in accordance with the following requirements:

a. The defects have been entirely removed and are judged not to affect the strength, use, or machinability of the castings when properly welded and stress relieved.

b. The proposed welding procedure, stress relief, and method of examination of the repair work have been submitted and approved.

2.2.6 Machine Work

***3**

All geometric and coordinate dimensioning methods on the contract plans shall be interpreted in accordance with ASME Y14.5M. All dimensions shown on drawings are finished dimensions and raw material specification tolerances are not to be used for the specified items. Sufficient machining stock shall be allowed to obtain the finished dimensions indicated on the contract drawings or specified herein. Parts shall be machined to the tolerances shown on the contract plans. Where tolerances are not shown on the contract plans items shall be machined as specified below. Like parts receiving machine work shall be interchangeable except as follows. Parts assembled together for drilling or reaming of holes or machining will not be required to be interchangeable with like parts.

***3**

2.2.6.1 Dimensional Tolerances

Dimensional tolerances for items described in the above paragraph titled FABRICATION that are designated by non-decimal dimensions or by nominal dimension shall be as follows.

a. Shafts, Pins, Trunnions, Axles: Tolerances for outside diameter and straightness shall be as follows.

1. Outside diameter of items designated by a nominal dimension and a class of fit shall be toleranced according to ASME B4.1 for the class of fit shown. Straightness along the length of the items shall be toleranced such that the item will assemble and maintain the requirements for the class of fit shown on the contract drawings. The toleranced dimensions shall be shown on the submitted detail drawings for approval.
2. Outside diameter of items designated by a nominal dimension and noted to refer to a bearing/bushing manufacturer for fit requirements shall be toleranced according to the select bearing/bushing manufactures published literature. Straightness on the length of the items shall be toleranced such that the item will assemble and maintain the fit requirements for the select bearing/bushing manufacturer. The toleranced dimensions shall be shown on the submitted detail drawings for approval.
3. Where fit requirements are not shown or noted on the outside diameter of items they shall be machined to +/- 0.0075" of the nominal diameter shown. Straightness along the length of items shall be sufficient to allow assembly and proper operation. The

toleranced dimensions shall be shown on the submitted detail drawings for approval.

b. Bearing Housings, Machine Brackets, Clevis and Eye Connections, Castings and Plates that are drilled, reamed, tapped or cut to accept bolted, bearing or pin connections: Tolerances for inside diameter, straightness, concentricity and perpendicularity.

1. Inside diameter of items designated by a nominal dimension and a class of fit shall be toleranced according to ASME B4.1 for the class of fit shown. Concentricity between aligned holes shall be toleranced such that the item will assemble and maintain the requirements for the class of fit shown on the contract drawings. Centerline of holes shall be straight to within 0.001". Any drilled, tapped, or reamed face of the listed items shall be perpendicular to within 0.002" of the centerline of the hole. The toleranced dimensions shall be shown on the submitted detail drawings for approval.

2. Inside diameter of items designated by a nominal dimension and noted to refer to the bearing/bushing manufacturer shall be toleranced according the requirements of the select bearing/bushing. Concentricity between aligned holes shall be toleranced such that the item will assemble and maintain the requirements for fit required by the selected bearing/bushing. Centerline of holes shall be straight to 0.001". Any drilled, tapped, or reamed face of the listed items shall be perpendicular to within 0.002" of the centerline of the hole. The toleranced dimensions shall be shown on the submitted detail drawings for approval.

3. Where fit requirements are not shown or noted on the inside diameter of items they shall be machined to +/- 0.0075" of the nominal diameter shown. Concentricity between aligned holes shall be toleranced such that the item will assemble and function properly. Centerline holes shall be straight to within 0.001". Any drilled, tapped, or reamed face of the listed items shall be perpendicular to within 0.002" of the centerline of the hole. The toleranced dimensions shall be shown on the submitted detail drawings for approval.

c. Bearing and Bushings

1. Self-Lubricating Bearings: Tolerances for selected bearings/bushings shall be determined per manufacturers recommendation or literature. Centerline of holes shall be straight to 0.001". Outside and inside diameters shall be concentric to 0.001"

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d. Flat Bearing and Sliding Surfaces: Tolerances for Straightness, Profile and Flatness.

1. Items shall be machined straight to +/- 0.007" of vertical and horizontal lines shown on the contract plans unless otherwise shown on the drawings. Also flatness shall be **maintained** over the surface of the items to +/- 0.005" unless otherwise indicated.

2. Items with angled and curved surfaces indicated on the contract drawings shall **be** machined with a profile tolerance of +/- 0.007". ***3**

2.2.6.2 Finished Surfaces

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Surface finishes indicated or specified shall be in accordance with ASME B46.1. Compliance with surface requirements shall be determined by profilometer or by sense of feel and visual inspection of the work compared to Roughness Comparison Specimens in accordance with the provisions of ASME B46.1. Values of roughness width and waviness height shall be consistent with the general type of finish specified by roughness height. Where the finish is not indicated for journal, bearing or sliding surfaces for the items stated in the paragraph titled FABRICATION, the surfaces shall be machined 63 microinch finish unless selected components such as bearings/bushings have more stringent requirements. Detail drawings submitted for approval shall indicate by a symbol which conforms to ASME B46.1 the required surface finish. Flaws such as scratches, ridges, holes, peaks, cracks, or checks which will make the part unsuitable for the intended use will be cause for rejection. The lay of surface finishes on sliding or rotating components shall be in the same direction as the intended motion of the parts.

***3**

2.2.6.3 Unfinished Surfaces

Unfinished surfaces on machine work items shall adhere to the following. All work shall be laid out to secure proper matching of adjoining unfinished surfaces on machined items unless otherwise directed. Unfinished surfaces shall be within 0.031" of the lines and dimensions shown on the contract plans. Where there are discrepancies greater than 0.031 inch between adjoining unfinished surfaces they shall be chipped and ground smooth or machined to secure proper alignment. Area of unfinished surfaces exceeding the previous tolerance shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts shall be filled in an approved manner.

2.2.7 Miscellaneous Provisions

2.2.7.1 Metallic Coatings

a. Zinc Coatings - Zinc coatings shall be applied in a manner and of a thickness and quality conforming to ASTM A 123. Where zinc coatings are destroyed by cutting, welding or other causes the affected areas shall be regalvanized. Coatings 2 ounces or heavier shall be regalvanized with a suitable low-melting zinc base alloy similar to the recommendations of the American Hot-Dip Galvanizers Association to the thickness and quality specified for the original zinc coating. Coatings less than 2 ounces shall be regalvanized by a repair compound conforming to MS MIL-P-21035.

***3**

b. NOT USED

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c. Chromium Coatings - Chromium coatings for engineering use shall be applied in conformity with ASTM B 177.

2.2.7.2 Cleaning of Corrosion-Resisting Steel

Oil, paint, and other foreign substances shall be removed from corrosion-resisting steel surfaces after fabrication. Cleaning shall be done by vapor degreasing or by the use of cleaners of the alkaline, emulsion or solvent type. After the surfaces have been cleaned they shall be given a final rinsing with clean water followed by a 24 hour period during which the surfaces are intermittently wet with clean water and then allowed to dry for the purpose of inspecting the clean surfaces. The surfaces shall be visually inspected for evidence of paint, oil, grease, welding slag, heat treatment scale, iron rust, or other forms of contamination. If evidence of foreign substance exist the surface shall be cleaned in accordance with the applicable provisions of ASTM A 380. The proposed method of treatment shall be furnished for approval. After treatment the surfaces shall be visually reinspected. Brushes used to remove foreign substances shall have only stainless steel or nonmetallic bristles. Any contamination occurring subsequent to the initial cleaning shall be removed by one or more of the methods indicated above.

2.2.8 Shop Assembly

Each machinery and structural unit furnished shall be assembled in the shop to determine the correctness of the fabrication and matching of the component parts unless otherwise specified. Tolerances shall not exceed those shown. Each unit assembled shall be closely checked to ensure that all necessary clearances have been provided and that binding does not occur in any moving part. Assembly in the shop shall be in the same position as final installation in the field unless otherwise specified. Assembly and disassembly work shall be performed in the presence of the Contracting Officer unless waived in writing. Errors or defects disclosed shall be immediately remedied by the Contractor without cost to the Government. Before disassembly for shipment each piece of a machinery or structural unit shall be match-marked to facilitate erection in the field. The location of match-marks shall be indicated by circling with a ring of white paint after the shop coat of paint has been applied or as otherwise directed.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

The Contractor shall have required material tests and analyses performed and certified by an approved laboratory to demonstrate that materials are in conformity with the specifications. These tests and analyses shall be performed and certified at the Contractor's expense. Tests, inspections, and verifications shall conform to the requirements of the particular sections of these specifications for the respective items of work unless otherwise specified or authorized. Tests shall be conducted in the presence of the Contracting Officer if so required. The Contractor shall furnish specimens and samples for additional independent tests and analyses upon request by the Contracting Officer. Specimens and samples shall be properly labeled and prepared for shipment.

2.3.1 Nondestructive Testing

When doubt exists as to the soundness of any material, part such part may be subjected to any form of nondestructive testing determined by the Contracting Officer. This may include ultrasonic, magnaflux, dye penetrant, x-ray, gamma ray, or any other test that will thoroughly investigate the part in question. The cost of such investigation will be borne by the Government. Any defects will be cause for rejection and rejected parts shall be replaced and retested at the Contractor's expense.

2.3.2 Tests of Machinery and Structural Units

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The details for tests of machinery and structural units shall conform to the requirements of the particular sections of these specifications covering these items. Each complete machinery and structural unit shall be assembled and tested in the shop in the presence of the Contracting Officer unless otherwise directed. **Shop assembled parts shall be match marked to insure proper field assembly.** Waiving of tests will not relieve the Contractor of responsibility for any fault in operation, workmanship or material that occurs before the completion of the contract or guarantee. After being installed at the site each complete machinery or structural unit shall be operated through a sufficient number of complete cycles to demonstrate to the satisfaction of the Contracting Officer that it meets the specified operational requirements in all respects.

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2.3.3 Inspection of Structural Steel Welding

The Contractor shall maintain an approved inspection system and perform required inspections in accordance with Contract Clause "CONTRACTOR INSPECTION SYSTEM". Welding shall be subject to inspection to determine conformance with the requirements of AWS D1.1or AWS D1.5 for the miter gates, or where applicable, the approved welding procedures and provisions stated in other sections of these specifications. Nondestructive examination of designated welds will be required. Supplemental examination of any joint or coupon cut from any location in any joint may be required.

2.3.3.1 Visual Examination

All visual examination of completed welds shall be cleaned and carefully examined for insufficient throat or leg sizes, cracks, undercutting, overlap, excessive convexity, or reinforcement and other surface defects to ensure compliance with the requirements of AWS D1.1, Section 3 and Section 9, Part D or AWS D1.5 for the miter gates. Defects shall be corrected as provided in paragraph 2.3.4, "Structural Steel Welding Repairs".

2.3.3.2 Nondestructive Examination

The nondestructive examination of shop and field welds shall be performed as designated or described in the sections of these specifications covering the particular items of work.

a. Testing Agency - The nondestructive examination of welds and the evaluation of examination tests as to the acceptability of the welds shall be performed by a testing agency adequately equipped and competent to perform such services or by the Contractor using suitable equipment and qualified personnel. In either case written approval of the examination procedures is required and the examination tests shall be made in the presence of the Contracting Officer. The evaluation of examination tests shall be subject to the approval and all records shall become the property of the Government.

b. Examination Procedures - Examination procedures shall conform to the following requirements.

(1) Ultrasonic Testing - Making, evaluating and reporting ultrasonic testing of welds shall conform to the requirements of AWS D1.1, Section 6, Part C or AWS D1.5, Section 6, Part C for the miter gates. The ultrasonic equipment shall be capable of making a permanent record of the test indications. A record shall be made of each weld tested.

(2) Radiographic Testing - Making, evaluating and reporting radiographic testing of welds shall conform to the requirements of AWS D1.1, Section 6, Part B or AWS D1.5 Section 6, Part B for the miter gates.

(3) Magnetic Particle Inspection - Magnetic particle inspection of welds shall conform to the applicable provisions of ASTM E 709.

(4) Dye Penetrant Inspection - Dye penetrant inspection of welds shall conform to the applicable provisions of ASTM E 165. If dye penetrant inspection is performed at the project site, the contractor shall address the disposal of waste dye in the Solid and Hazardous Waste Management Plan as required by Section 01410.

c. Acceptability of Welds - Welds shall be unacceptable if shown to have defects prohibited by AWS D1.1, Section 6 or AWS D1.5, Subsection 9.21 for miter gates. If the welds possess any degree of incomplete fusion, inadequate penetration or undercutting they shall be unacceptable .

d. Welds to be Subject to Nondestructive Examination

Welds shall be tested by Nondestructive Examination methods as outlined below and on the contract drawings. All test lengths shall be at least 25 percent of the weld length, with a minimum of three inches, unless otherwise noted on the drawings.

CULVERT VALVES

TYPE OF NDT	LOCATION	DRAWNG NO.
Ultrasonic	Strut to Trunnion Casting	S-252
Ultrasonic	Strut to Flange Splices	S-252
Magnetic Particle	Strut to Radial Girder	S-252
Ultrasonic	Radial Girder Flange at Strut	S-252
Magnetic Particle	Pin Plates and Diaphragm Plates to Trunnion Girder	S-251

CULVERT VALVES

CULVERT BULKHEADS

TYPE OF NDT	LOCATION	DRAWING NO.
Ultrasonic	Lifting Hook to Web	S-261

2.3.3.3 Miter Gates

Radiographic, Ultrasonic, and Magnetic Particle testing will be required as indicated on the drawings. A minimum of 15%(where 15% means 1.5" in 10" of every weld) of all welds shall be tested.

2.3.3.4 Test Coupons

The Government reserves the right to require the Contractor to remove coupons from completed work when doubt as to soundness cannot be resolved by nondestructive examination. Should tests of any two coupons cut from the work of any welder show strengths less than that specified for the base metal, it will be considered evidence of negligence or incompetence and such welder shall be removed from the work. When coupons are removed from any part of a structure the members cut shall be repaired in a neat manner with joints of the proper type to develop the full strength of the members. Repaired joints shall be peened as approved or directed to relieve residual stress. The expense for removing and testing coupons, repairing cut members, and the nondestructive examination of repairs shall be borne by the Government or the Contractor in accordance with the Contract Clauses INSPECTION AND ACCEPTANCE.

2.3.3.5 Supplemental Examination

When the soundness of any weld is suspected of being deficient due to faulty welding or stresses that might occur during shipment or erection, the Government reserves the right to perform nondestructive supplemental examinations before final acceptance. The cost of such inspection will be borne by the Government. All repairs and re-examination will be performed by the Contractor at no additional cost to the Government.

2.3.4 Structural Steel Welding Repairs

Defective welds in the structural steel welding repairs shall be repaired in accordance with AWS D1.1, Subsection 3.7 or AWS D1.5, Subsection 3.7 for the miter gates. Defective weld metal shall be removed to sound metal by use of air carbon-arc or oxygen gouging. Oxygen gouging shall not be used on ASTM A 514/A 514M steel. The surfaces shall be thoroughly cleaned before welding. Welds that have been repaired shall be retested by the same methods used in the original inspection. Except for the repair of members cut to remove test coupons and found to have acceptable weld costs of repairs and retesting shall be borne by the Contractor.

2.3.5 Inspection and Testing of Steel Stud Welding

Fabrication and verification inspection and testing of steel stud welding shall conform to the requirements of AWS D1.1, Subsection 7.8 except as otherwise specified. The Contracting Officer will serve as the verification inspector. One stud in every 100 and studs that do not show a full 360 degree weld flash, have been repaired by welding or whose reduction in length due to welding is less than normal shall be bent or torque tested as required by AWS D1.1, Subsection 7.8. If any of these studs fail two additional studs shall be bent or torque tested. If either of the two additional studs fail all of the studs represented by the tests shall be rejected. Studs that crack under testing in either the weld, base metal or shank shall be rejected and replaced by the Contractor at no additional cost.

2.3.6 Inspection of Steel Castings

The Contractor shall perform radiographic inspection of steel castings as designated and as described in the section of these specifications covering the particular item of work. The procedure for making, evaluating, and reporting the radiographic inspection shall conform to the requirements of ASTM E 94. The castings shall be unacceptable if shown to have defects of greater severity than the applicable reference standard specified in the following table:

DISCONTINUITY TYPE	SEVERITY LEVELS OR CLASSES
Gas and Blowholes	4
Sand Spots and Inclusions	3
Internal Shrinkage	2
Hot Tears, Cracks	1
Unfused Chaplets	1
Internal Chills	1

The applicable referenced standards shall be as illustrated in ASTM E 446. The evaluation of the radiographs shall be subject to approval and all records shall become the property of the Government.

PART 3 EXECUTION

3.1 INSTALLATION

All parts to be installed shall be thoroughly cleaned. Packing compounds, rust, dirt, grit and other foreign matter shall be removed. Holes and grooves for lubrication shall be cleaned. Enclosed chambers or passages shall be examined to make sure that they are free from damaging materials. Where units or items are shipped as assemblies they will be inspected prior to installation. Disassembly, cleaning and lubrication will not be required except where necessary to place the assembly in a clean and properly lubricated condition. Pipe wrenches, cold chisels or other tools likely to cause damage to the surfaces of rods, nuts or other parts shall not be used for assembling and tightening parts. Bolts and screws shall be tightened firmly and uniformly but care shall be taken not to overstress the threads. When a half nut is used for locking a full nut the half nut shall be placed first and followed by the full nut. Threads of all bolts except high strength bolts, nuts and screws shall be lubricated with an approved lubricant before assembly. Threads of corrosion-resisting steel bolts and nuts shall be coated with an approved anti-galling compound. Driving and drifting bolts or keys will not be permitted.

3.1.1 Alignment and Setting

Each machinery or structural unit shall be accurately aligned by the use of steel shims or other approved methods so that no binding in any moving parts or distortion of any member occurs before it is fastened in place. The alignment of all parts with respect to each other shall be true within the respective tolerances required. Machines shall be set true to the elevations shown.

3.1.2 Blocking and Wedges

All blocking and wedges used during installation for the support of parts to be grouted in foundations shall be removed before final grouting unless otherwise directed. Blocking and wedges left in the foundations with approval shall be of steel or iron only, and shall be thoroughly cleaned of dirt and debris before grouting.

3.1.3 Foundations and Grouting

Concreting of subbases and frames and the final grouting under parts of machines shall be in accordance with the procedures as specified in Section 03301 "CAST-IN-PLACE STRUCTURAL CONCRETE".

3.2 PROTECTION OF FINISHED WORK

3.2.1 Machined Surfaces

Machined surfaces shall be thoroughly cleaned of foreign matter. All finished surfaces shall be protected by suitable means. Unassembled pins and bolts shall be oiled and wrapped with moisture resistant paper or protected by other approved means. Finished surfaces of ferrous metals to be in bolted contact shall be washed with an approved rust inhibitor and coated with an approved rust resisting compound for temporary protection during fabrication, shipping and storage periods. Finished surfaces of metals which shall be exposed after installation except corrosion resisting steel or nonferrous metals shall be painted as specified in Section 09965 PAINTING HYDRAULIC STRUCTURES AND APPURTENANT WORKS.

3.2.2 Aluminum

Aluminum that shall be in contact with grout or concrete shall be protected from galvanic or corrosive action by being given a coat of zinc-chromate primer and a coat of aluminum paint. Aluminum in contact with structural steel shall be protected against galvanic or corrosive action by being given a coat of zinc-chromate primer and a coat of aluminum paint. The zinc-chromate primer shall conform to SAE AMS 3110. The aluminum paint shall consist of a aluminum paste conforming to ASTM D 962, spar varnish conforming to SAE AMS 3132, and thinner compatible with the varnish. The aluminum paint shall be field mixed in proportion of 2 pounds of paste, not more than one gallon of spar varnish, and not more than one pint of thinner.

3.3 TESTS

3.3.1 Workmanship

Workmanship shall be of the highest grade and in accordance with the best modern practices to conform with the specifications for the item of work being furnished.

3.3.2 Production Welding

Production welding shall conform to the requirements of AWS D1.1 or AWS D1.2 or AWS D1.5as applicable. Studs on which pre-production testing is to be performed shall be welded in the same general position as required on production items flat, vertical, overhead or sloping. Test and production stud welding will be subjected to visual examination or inspection. If the reduction of the length of studs becomes less than normal as they are welded, welding shall be stopped immediately and not resumed until the cause has been corrected.

-- End of Section --

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DIVISION 11 - EQUIPMENT

SECTION 11150

VEHICLE GATE OPERATOR SYSTEMS

01/02

-- End of Section Table of Contents --

SECTION 11150

VEHICLE GATE OPERATOR SYSTEMS
01/02

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Data

Gate Operator SystemS ; GA, RE.

Provide product literature describing functional aspects, technical data, processor information, entrapment protection and other information for a complete system.

SD-06 Instructions

Cantilever Slide and Swing Gate Systems instructions.

Provide manufacturers detailed instructions for cantilever slide and swing gate systems.

SD-19 Operations and Maintenance Manuals

Cantilever Slide and Swing Gate System O&M Manuals

Provide six copies of manufacturers O&M manuals for cantilever slide and swing gate systems.

1.3 WARRANTY

Provide maunfacturers' limited two year warranty for each item.

1.4 MEASUREMENT AND PAYMENT

The measurement for the Vehicle Gate Operator Systems shall be lump sum. Payment for construction will be made at the contract lump sum price for "Vehicle Gate Operator Systems" as listed in the bidding schedule. Payment shall include the cost of obtaining all materials, labor, and equipment required for placement of the system including foundations.

PART 2 PRODUCTS

2.1 CANTILEVER SLIDE GATE SYSTEM

All equipment shall be provided by the same manufacturer. System shall consist of mechanical slide gate operators, PC programable access controllers, key pads, telephone access system, heavy duty goose neck standards, pavement hold loops and all accessories necessary for a complete and functional system.

2.1.1 Slide Gate Operator

1. The slide gate operator shall be designed for Class II operation in accordance with UL325 and UL991.

2. An inherent reverse system in the gate operator shall consist of a primary (type A) sensing system and one secondary device (type B1, B2 or D) that will reverse the gate if an obstruction is sensed in either the opening or closing gate cycles. The control board shall check the primary entrapment sensing system circuit at each cycle of the operator. Should the control board detect a fault in the system, the motor shall not be allowed to start.

3. The gate operator shall immediately stop and activate the internal alarm upon sensing an entrapment and shall require activation of the reset switch prior to returning to normal operations as required by the UL 325 safety standard. For enhanced safety, the operator shall upon sensing an entrapment, immediately release all pressure on the gate and shall immediately assume a fail-safe condition to allow any entrapment the opportunity to free itself without the need of outside intervention.

4. The vehicular slide gate operator shall be equipped with a fail-secure release system. When power to the operator has been lost, the operator shall assume a fail-secure condition and the gates will remain locked. Keyed release option shall open gates.

5. A battery powered DC drive system shall be provided. The DC drive system shall monitor the primary power source and shall power the gate upon command, or automatically, if power to the operator is interrupted. When power is restored, the DC drive system shall automatically set the operator to return to normal operation. The system shall provide a trickle charge to the batteries to maintain nominal battery power levels.

6. The vehicular slide gate operator shall have output for connection to an electronic monitoring device. The monitoring device shall maintain a detailed electronic record of cycles, input errors, loop detector errors, forced entry attempts, obstruction hits, and each time power is applied to the operator. This record shall be time and date stamped and shall be analyzed using proprietary account manager software in Windows format.

7. Slide Gate Operator shall contain a 1 horsepower continuous duty motor, operating at 120 volts single phase AC power only. Primary reduction and power transfer shall be provided by a combination gear-reducing V-belt drive train. The gate operator speed shall be set at 1 foot per second (nominal). The pulling medium shall consist of #40 roller chain. The gate operator shall have two convenience outlets available for accessory

transformer power, and also have a built in lockable power disconnect switch. A positive dead bolt shall operate in a failsafe mode, i.e.: only when the gate is forced open, to reduce solenoid lock wear and failure, or be capable of operating in a fail-secure mode, i.e.: after each operation.

8. Loop Detectors (two channel detectors) shall be provided to prevent gates from closing on vehicular traffic.

9. Slide Gate Operator shall be model 9150 gate operator as manufacturered by DoorKing Inc., <u>or approved equal</u>.

2.2 Processor

Slide gate operator shall use a microprocessor based control board that will control all functions of operation. The control board will be of such design that relays, contactors, or limit switches are not needed and not used. The slide gate operator shall be able to set its own open and close limit settings. An adjustable timer shall be built into the control board to allow the gate to automatically close. Control board shall have two ports for plug in of required loop detectors. A dry set of relay contacts shall be available for external use, and shall have four programmable functions.

2.1.3 Programmable Access Controller (Gate A and D)

The programmable access controllers shall provide access control through the vehicular access gates and maintain the system remotely from a PC. Access shall be by digital code. System shall include software to provide access documentation stored and maintained on a user supplied PC. The information is then sent via modem to the access controller. Whenever the data base needs to be updated, changes are easily made at the PC, and then sent to the unit. The controller maintains a history of the last 8000 transactions which can be down loaded to the PC for storage or printing. The transaction report includes all of the activity at the access point, including date, time, device number, user name, and if the access was granted or denied. Programmable access controller shall be model 1818 as manufacturered by DoorKing Inc. <u>or approved equal</u>.

2.1.3.1 Program Mode (Gate D)

Gate D shall be pre-programmed to open at pre-set times to approximate year around dawn to dust operation. Settings shall be based upon eastern standard time zone and automatically change to daylight saving time and back. When in the closed mode (dusk to dawn), preassigned access codes shall be inputed on the keypad to obtain access (level 1, relay 1) or by intercom. In the event of an elevated secure mode, a second set of access codes (level 2, relay 2) shall be inputed on the key pad to obtain access. Otherwise, the gates shall be capable of being manually closed overiding the pre-set mode.

2.1.3.1 Program Mode (Gate A)

Gate A shall be programmed closed at all times and opened only by keypad or by intercom.

2.2 SWING GATE OPERATOR SYSTEM (Gate C)

All equipment shall be provided by the same manufacturer. System shall consist of mechanical swing gate operators, PC programable access controllers, key pads, telephone access system, heavy duty goose neck standards, pavement hold loops and all accessories necessary for a complete and functional system.

2.2.1 Swing gate Operator

1. The swing gate operator system shall be designed for Class II operation in accordance with UL325 and UL 991.

2. An inherent reverse system in the gate operator shall consist of a primary (type A) sensing system and one secondary device (type B1, C or D) that will reverse the gate if an obstruction is sensed in both the opening and closing gate cycles. The control board shall check the primary entrapment sensing system circuit at each cycle of the operator. Should the control board detect a fault in the system, the motor shall not be allowed to start.

3. The gate operator shall immediately stop and activate the internal alarm upon sensing an entrapment and shall require activation of the reset switch prior to returning to normal operations as required by the UL 325 safety standard. For enhanced safety, the operator shall upon sensing an entrapment, immediately release all pressure on the gate and shall immediately assume a fail-safe condition to allow any entrapment the opportunity to free itself without the need of outside intervention.

4. The vehicular swing gate operator shall be equipped with a fail-secure release system. When power to the operator has been lost, the operator shall assume a fail-secure condition and the gates will remain locked. Keyed release option shall open gates.

5. A battery powered DC drive system shall be provided. The DC drive system shall monitor the primary power source and shall power the gate upon command, or automatically, if power to the operator is interrupted. When power is restored, the DC drive system shall automatically set the operator to return to normal operation. The system shall provide a trickle charge to the batteries to maintain nominal battery power levels.

6. The vehicular swing gate operator shall have output for connection to an electronic monitoring device. The monitoring device shall maintain a detailed electronic record of cycles, input errors, loop detector errors, forced entry attempts, obstruction hits, and each time power is applied to the operator. This record shall be time and date stamped and shall be analyzed using proprietary account manager software in Windows format.

7. Swing Gate Operator shall contain a 1 horsepower continuous duty motor, operating at 120 volts single phase AC power only. Primary reduction shall be provided by a single V-belt with power transfer provided by worm gear. Harmonic linkage arm shall function from the bottom of the gate operator

and shall sart the gate slowly, accelerate through the cycle,then slow down prior to stopping to prevent the gate from bouncing. The gate operator shall have two convenience outlets available for accessory transformer power, and also have a built in lockable power disconnect switch.

8. Loop Detectors (two channel detectors) shall be provided to prevent gates from closing on vehicular traffic.

9. Swing Gate Operator shall be model 6300 as manufacturered by DoorKing Inc., or approved equal.

2.2.2 Processor

Swing gate operator shall use a microprocessor based control board that will control all functions of operation. The control board will be of such design that relays, contactors, or limit switches are not needed and not used. The swing gate operator shall be able to set its own open and close limit settings. An adjustable timer shall be built into the control board to allow the gate to automatically close. Operator shall have two ports for plug in of required loop detectors. A dry set of relay contacts shall be available for external use, and shall have four programmable functions.

2.2.3 Programmable Access Controller

The programmable access controller shall provide access control through the vehicular access gates and maintain the system remotely from a PC. Access shall be by digital code. System shall include software to provide access documentation stored and maintained on a user supplied PC. The information is then sent via modem to the access controller. Whenever the data base needs to be updated, changes are easily made at the PC, and then sent to the unit. The controller maintains a history of the last 8000 transactions which can be down loaded to the PC for storage or printing. The transaction report includes all of the activity at the access point, including date, time, device number, user name, and if the access was granted or denied. Programmable access controller shall be model 1818 as manufacturered by DoorKing Inc. or approved equal.

2.2.4 Program Mo (Gate C)de

Gate C shall be pre-programmed to open at pre-set times to approximate year around dawn to dust operation. Settings shall be based upon eastern standard time zone and automatically change to daylight saving time and back. When in the closed mode (dusk to dawn), preassigned access codes shall be inputed on the keypad to obtain access (level 1, relay 1) or by intercom. In the event of an elevated secure mode, a second set of access codes (level 2, relay 2) shall be inputed on the key pad to obtain access. Otherwise, the gates shall be capable of being manually closed overiding the pre-set mode.

2.3 TELEPHONE ENTRY SYSTEM (Gate A, C and D)

Telephone entry system shall provide voice communication and access control for both directions of the vehicular access gates. Visitors enter a displayed preprogrammed four-digit number on the system's keypad to automatically establish communication with the lock operator in the 'A' building. (If that person is not available up to three additional displayed preprogrammed four-digit numbers may be used to establish communication at other pre-determined locations). The lock operator can either grant or deny access from their own telephone. System shall include a state-of-the-art microprocessor that controls all functions of the system. Full duplex communication shall provide clear two-way voice communication. A built in clock calendar, which has its own standby power source, shall provide time related functions such as automatic relay activation, entry code time zones, and "flash" entry codes which are programmed to operate on a specific date only. Telephone Entry System shall be model 1520 as manufacturered by DoorKing Inc.,<u>or approved equal.</u>

2.4 HEAVY GOOSE NECK STANDARDS

Goose neck standards shall be used for mounting keypad access controllers and telephone keypad controllers on one mount for Gates C and D (each direction), and for mounting just the keypad access controller on one mount for Gate A. Standard shall be 42" tall, 2"x4" painted (black) galvanized steel tube and sweeps out 12". Standards shall be provided with surge suppressors for power and telephone lines. Standard shall be base plate mounted and compatible with system described previously.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be in accordance with the approved manufacturers' instructions. Power and telephone lines shall be coordinated with concrete and other prep work. Mounting plates and brackets shall be as required for approved equipment. The slide and swing gate operators and goose neck standard are designed to be mounted directly to a concrete pad. Wiring shall be in accordance with national electric codes. All splicesshall be in accessible junction boxes or on terminal boards.

3.2 SYSTEM INITIALIZATION AND PROGRAMMING

System shall be turned on and andjustments made to meet requirements and on-site conditions. Program levels shall be tested and shall be functional as specified.

3.3 TESTING

Upon completion of construction, a field test shall be performed for each gate and operator. The test shall include opening the gates, both electrically and manually, through its complete range of operation. The Contracting Officer shall be notified at least 7 days prior to the beginning of the field test. The Contractor shall furnish all equipment and make all necessary corrections and adjustments prior to tests witnessed by the Contracting Officer. Any conditions that interfere with the proper operation of the gate operators disclosed by the test shall be corrected at no additional cost to the Government. Adjustments and repairs shall be done by the Contractor under the direction of the Contracting Officer. After adjustments are made to assure correct functioning of components, applicable tests shall be completed.

3.4 USER INSTRUCTION

Contractor shall conduct up to (1) hour of instruction in use and operation of the system to designated user representatives, within 30 days of acceptance. In addition, Contractor shall conduct up to (1) hour of technical training in trouble shooting and service of the system to designated owner representatives within 90 days of system acceptance.

-- End of Section --

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DIVISION 11 - EQUIPMENT

SECTION 11285

MITER GATES

01/94

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SECTION 11285

MITER GATES
01/94

PART 1 GENERAL
***3**

Three sets of miter gates are to be furnished under this contract. Two sets of gates (four gate leaves) shall be installed in the new lock chamber and one set of spare gates (two gate leaves) installed on the storage piers (Piers **1&2**)at the McAlpine Wharf Facility. The contractor **shall** use the Wharf area to erect, assemble, paint and install the spare gates. The wharf deck is rated for an HS-**20** AASHTO live load or an 1000 psf uniform live load. Cribbing of the spare gates or work equipment may be necessary so that the capacity of the deck is not exceeded. The miter gates are considered to be cyclically loaded structures and shall be welded in accordance with AWS D1.5. Certain members of the miter gate are considered fracture critical and their fabrication shall adhere to the fracture control plan given in AWS D1.5. Fracture critical members are indicated either on the contract drawings or specified in this section.

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1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 6/A 6M	(2001) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A 53	(1996) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 167	(1996) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 176	(1996 Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A 240/A 240M	(1996) Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A 307	(1994) Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength
ASTM A 312/A 312M	(2001) Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes

ASTM A 325	(1996) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 564/A 564M	(1995) Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A 668/A 668M	(1996) Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM D 395	(1989; R 1994) Rubber Property - Compression Set
ASTM D 412	(1992) Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension
ASTM D 413	(1982; R 1993) Rubber Property - Adhesion to Flexible Substrate
ASTM D 471	(1996) Rubber Property - Effect of Liquids
ASTM D 572	(1988; R 1994) Rubber - Deterioration by Heat and Oxygen
ASTM D 2240	(1995) Rubber Property - Durometer Hardness

AMERICAN WELDING SOCIETY (AWS)

AWS D1.5	(1996) Bridge Welding Code

SSPC: THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 12	(1991) Cold-Applied Asphalt Mastic (Extra Thick Film)

1.2 UNIT PRICES

1.2.1 Furnishing and Installing Miter Gates

1.2.1.1 Payment

***3**

Payment will be made for costs associated with furnishing and installing miter gates and appurtenant items, which includes full compensation for the materials, fabrication, delivery, installation, painting, and testing of miter gates and appurtenant items including gate leaves, diagonals, hydraulic cylinder connections, miter guides, miter latches, recess latch strikes and gate latching devices, adjustable quoin and miter block assemblies, gudgeon top anchorages, pintle assemblies, bridgeways, gudgeon embedded anchorages, embedded wall quoins, sill assemblies, seal assemblies, miter gate latches, bumpers, fenders, and all other items necessary for complete installation. Two sets of gate leaves shall be installed in the new lock chamber. A third set (spare set) of gate leaves shall be installed on the storage piers provided at the McAlpine Wharf facility. **The spare gates do not require the following items: embedded gudgeon anchorage, pintle base and embedded wall quoins.**

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1.2.1.2 Unit of Measure

Unit of measure: lump sum.

1.3 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Data

Diagonals Prestressing; GA, ED.

Diagonal prestressing plan shall be submitted and approved prior to initiating the prestressing operations. Diagonal prestressing record shall be submitted prior to completion of the contract.

Bearing and Bushing Specifications; GA, ED.

Bearing and bushing specifications for proposed product shall be approved prior to fabrication of pertinent components. Manufacturer recommended running clearances and interference fit tolerances for bearings and bushings shall be submitted prior to fabrication of the bushings.

SD-04 Drawings

Detail Drawings; GA, ED.

Detail drawings shall be submitted as specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

SD-07 Schedules

Materials; FIO.

Materials orders, materials lists and materials shipping bills shall be submitted as specified in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

SD-08 Statements

Welding Procedures; GA, ED.

Schedules of welding procedures as specified in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

SD-09 Reports

Tests, Inspections, and Verifications; FIO.

Certified test reports for material tests shall be submitted with all materials delivered to the site.

SD-13 Certificates

Epoxy Filler; FIO.

Manufacturer's certificate for epoxy filler shall be submitted with the material delivered to the site.

SD-14 Samples

Samples; GA, ED.

Samples shall be submitted and approved prior to use of the represented materials or items in the work. Samples of standard and shop fabricated items shall be full size and complete as required for installation in the work. Approved samples may be installed in the work provided each sample is clearly identified and its location recorded.

SD-18 Records

Materials Disposition; FIO.

System of identification which shows the disposition of specific lots of approved materials and fabricated items in the work shall be submitted before completion of the contract.

Diagonals Prestressing; FIO.

Diagonal prestressing records shall be submitted immediately after completion of the prestressing operations.

1.4 QUALIFICATION OF WELDERS AND WELDING OPERATORS

Qualification of welders and welding operators shall conform to the requirements of Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

1.5 DELIVERY, STORAGE, AND HANDLING

Delivery, handling, and storage of materials and fabricated items shall conform to the requirements specified herein and in Section 05055METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Materials and equipment delivered to the site by the Contracting Officer shall be unloaded by the Contractor. The Contractor shall verify the condition and quantity of the items delivered by the Contracting Officer and acknowledge receipt and condition thereof in writing to the Contracting Officer. If delivered items are damaged or a shortage is determined, the Contractor shall notify the Contracting Officer of such in writing within 24 hours after delivery.

1.5.1 Rubber Seals

Rubber seals shall be stored in a place which permits free circulation of air, maintains a temperature of 70 degrees F or less, and prevents the rubber from being exposed to the direct rays of the sun. Rubber seals shall be kept free of oils, grease, and other materials which would deteriorate the rubber. Rubber seals shall not be distorted during handling.

1.5.2 Epoxy Filler

Epoxy filler shall be delivered from the manufacturer just prior to use in the work to insure receipt of recently manufactured material and shall be stored under cover, out of direct sunlight, and at a temperature between 65 to 85 degrees F.

PART 2 PRODUCTS

2.1 MATERIALS

Materials orders, materials lists and materials shipping bills shall conform with the requirements of Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.1.1 Metals

Structural steel, steel forgings, steel castings, stainless steel, bronze, aluminum bronze and other metal materials used for fabrication shall conform to the requirements shown on the contract drawings and specified herein and in Section 05502 METALS: MISCELLANEOUS, STANDARD ARTICLES, SHOP FABRICATED ITEMS.

2.1.1.1 Structural Steel

Structural steel shall conform to ASTM A36 unless noted otherwise. All structural steel denoted as "fracture critical" on the contract drawings shall have a minimum Charpy V-notch toughness of 25 ft-lb at 40 degrees F. In addition, the steel for the diagonals, diagonal anchorages, anchor arms, link plates, embedded anchorage pin plates, and gudgeon hood shall all meet the Charpy requirements listed above. The contractor shall bear the cost of the Charpy test for each mill run.

2.1.1.2 Structural Steel Plates

Structural steel plates shall conform to standards indicated on the contract plans or ASTM A 36

2.1.1.3 Structural Steel Shapes

Structural steel shapes shall conform to standards indicated on the contract plans or ASTM A 500, Grade B or ASTM A 36 as applicable.

2.1.1.4 Steel Pipe

Steel pipe shall conform to ASTM A 53, Type S, Grade B, seamless, black, nominal size and weight class or outside diameter and nominal wall thickness as shown.

2.1.1.5 Stainless Steel Bars and Shapes

Stainless steel bars and shapes shall conform to ASTM A 240, UNS S20910 "Nitronic 60", Condition A, hot-finished or cold-finished,. ASTM A 564/A 564M, UNS S 17400, precipitation harden hardening, heat treated as indicated on the contract plans.

2.1.1.6 Stainless Steel Plate, Sheet, and Strip

Stainless steel plate, sheet, and strip shall conform to ASTM A 167, UNS S 30400; ASTM A 176, UNS S40500 or UNS S41008; and ASTM A 240/A 240M, UNS SS 20910 "Nitronic 60", as indicated on the contract plans. Plate finish shall be hot-rolled, annealed or heat-treated and blast-cleaned or pickled. Sheet and strip finish shall be No. 1.

2.1.1.7 Stainless Steel Pipe

Stainless steel pipe shall conform to ASTM A 312/A 312M Type 316

2.1.2 Rubber Seals

Rubber seals shall be compounded of natural rubber, synthetic polyisoprene, or a blend of both and shall contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers.

2.1.2.1 Physical Characteristics

Physical characteristics of the seals shall meet the following requirements:

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Tensile Strength	2,500 psi (min.)	ASTM D 412
Elongation at Break	450% (min.)	ASTM D 412
300% Modulus	900 psi (min.)	ASTM D 412
Durometer Hardness (Shore Type A)	60 to 70	ASTM D 2240
*Water Absorption	5% by weight (max.)	ASTM D 471
Compression Set	30% (max.)	ASTM D 395

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Tensile Strength (after aging 48 hrs)	80% tensile strength (min.)	ASTM D 572

* The "Water Absorption" test shall be performed with distilled water. The washed specimen shall be blotted dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees for 22 plus or minus 1/4 hour. The specimen shall be removed, allowed to cool to room temperature in air, and weighed. The weight shall be recorded to the nearest 1 mg as M subscript 1 (M subscript 1 is defined in ASTM D 471). The immersion temperature shall be 70 degrees C plus or minus 1 degree and the duration of immersion shall be 166 hours.

2.1.3 Epoxy Filler

Epoxy filler shall be an approved epoxy resin formulation equal to "Nordback for Locks and Dams," a product of Loctite Corporation., or an approved equal, with a specific gravity of 1.70 to 1.75, minimum compressive strength after 72 hours at 70 degrees F of 10,00 psi, and maximum shrinkage of 0.15 percent. The manufacturer must certify that the material meets or exceeds the specified physical properties.2.1.4 Bumpers and Fenders

Bumpers and fenders shall be made of a rubber backing with an UHMW plastic fender as shown on the drawings: The properties of the rubber shall conform to the following:

PHYSICAL TEST	TEST VALUE	SPECIFICATION
Tensile Strength	2,500 psi (min.)	ASTM D 412
Elongation at Break	300% (min.)	ASTM D 412
300% Modulus	900 psi (min.)	ASTM D 412
Durometer Hardness (Shore Type A)	70 +/-5	ASTM D 2240
*Water Absorption	5% by weight (max.)	ASTM D 471
Compression Set	25% (max.)	ASTM D 395
Tensile Strength (after aging 48 hrs)	80% tensile strength (min.)	ASTM D 572

The UHMW plastic shall be Poly Hi Solidur Tivar Uniblend (yellow) or approved equal.

2.1.8 Asphalt Mastic

SSPC Paint 12.

2.1.5 Anti-Seize Thread Lubricant

Shall be Loctite Corporation's Nickel Anti-Seize Lubricant, Product number 771 or equal. Anti-seize Thread lubricant shall consist of mineral oil, nickel and graphite and be in paste form. It shall prevent galling of threads up to tempertures of 1400 deg F. The lubricant will be compatible with stainless and carbon steels. Anti-Seize thread lubricant shall prevent signs of corrosion for 168 hours of exposure to salt water spray in accordance with ASTM B 117. Wear resistance shall defined by a fail load of 7600 psi per ASTM D 2509. Friction coefficient shall be 0.10 when applied to bolt threads.

2.2 MANUFACTURED UNITS

2.2.1 Threaded Fasteners

Bolts, nuts, washers, screws and other manufactured units shall conform with the requirements shown on the contact plans and specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Threaded Fastener Certifications for each type of bolt, nut, screw, and stud used in the fabrication shall be furnished to the Contracting Officer.

2.2.1.1 Bolts, Nuts and Washers

High-strength bolts, nuts, and washers shall conform to ASTM A 325, Type 1, Bolts, nuts, studs, stud bolts and bolting materials other than high-strength shall conform to ASTM A 307, Grade A. Stainless Steel bolts, nuts, set screws and washers used for Adjustable Quoin and Miter Block Assemblies, Embedded Wall Quoin and Gate Latching Devices shall be of the type shown on the contract drawings. Stainless bolts and nuts shall be of a different type to prevent galling

Bolts 1/2 inch and larger shall have hexagon heads. The finished shank of bolts shall be long enough to provide full bearing. Washers for use with bolts shall conform to the requirements specified in the applicable specification for bolts.

2.2.1.2 Screws

Screws shall be of the type indicated on the drawings.

2.2.1.3 Studs

Studs shall conform to the requirements of Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.2.2 Bearings and Bushings

Bearing and Bushing Specifications shall be self-lubricating bearings manufactured from a non-metallic material. Bearings shall be SXL high pressure composite bearings as manufactured by Thordon Bearings, Inc., 3225

Mainway, Burlington, Ontario, Canada L7M 1A6, or Feroform T814 bearings produced by HMI Wearing and Bearing Products, 200 North Service Road, West, Unit #1, Suite 303, Oakville, Ontario, Canada, 66M 2V1, +(888) 576-3545, or approved equal.

2.3 FABRICATION

2.3.1 Detail Drawings

Detail drawings, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, shall conform to the requirements specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.1.1 Fabrication Drawings

Fabrication drawings shall show complete details of materials, tolerances, connections, and proposed welding sequences which clearly differentiate shop welds and field welds.

2.3.1.2 Shop Assembly Drawings

Shop assembly drawings shall provide details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

2.3.1.3 Delivery Drawings

Delivery drawings shall provide descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

2.3.1.4 Field Installation Drawings

Field installation drawings shall provide a detailed description of the field installation procedures. The description shall include the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment; plan for prestressing gate leaf diagonals, which shall include descriptions of connections, riggings, anchorages, and measuring equipment; methods for installing quoin and miter blocks, including checking and maintaining alignments of the blocks during concreting and placement of epoxy filler; and methods for installing other appurtenant items.

2.3.2 Structural Fabrication

Structural fabrication shall conform with the requirements shown and specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Components shall be shop-fabricated of the materials specified and shown. Dimensional tolerances shall be as specified and shown on the drawings. Splices shall occur only where shown or approved. Pin holes shall be bored in components after welding, straightening, stress-relieving, and threading operations are completed. Brackets, eye bar sections, and other components requiring straightening shall be straightened by methods which will not damage the material. Bronze bushings shall be press-fitted with supporting components. Bolt connections, lugs, clips, or other pick-up assembly devices shall be provided for components as shown and required for proper assembly and installation. Provisions shall be made for the installation of cathodic protection system devices and other appurtenances as required.

2.3.3 Welding

Welding shall conform with the requirements of AWS D1.5, , the requirements specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Welds shall be of the type shown on the contract drawings and approved detail drawings. Nondestructive examination is required on the major shop and field welds of the type and location indicated on the drawings.. Welds which have been designated to receive radiographic examination and are found to be inaccessible to a radiation source or film, or are otherwise so situated that radiographic examination is not feasible may be examined, with written approval, by dye penetrant, magnetic particle tests, or ultrasonic tests. Components shall be stress-relief heat treated after welding where shown. Stress-relieving of components shall be performed prior to the attachment of miscellaneous appurtenances. The diagonals, embedded gudgeon A-Frames, and gudgeon hood are fracture critical members and shall follow the fracture control plan as given in AWS D1.5 Section 12.

2.3.4 Threaded Connections

Bolted connections shall be installed in conformance with the requirements specified in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.5 Machine Work

Machine work shall conform with the requirements specified in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.6 Miscellaneous Provisions

Miscellaneous provisions for fabrication shall conform with the requirements specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.3.7 Fabrications

2.3.7.1 Gate Leaf

Gate leaf shall be of welded structural steel and stainless steel fabrication consisting of horizontal girders; intercostals; diaphragms;, quoin and miter posts; adjustable quoin and miter block assemblies; gudgeon pin hood, hydraulic operating cylinder connection, skin plate, and adjustable diagonals. Gate leaf shall be shop-fabricated. Contractor proposed shop-fabrication of gate leaf in separate segments to facilitate handling and shipping must be approved by the Contracting Officer and shall be as shown on approved detail drawings. Such segments shall permit easy field-assembly and shall be as few as practicable to minimize the number of joints to be field-welded. The overall height and width of the gate leaf shall not vary from the nominal dimension or differ from the mating gate leaf by more than 1/4 inch.

End plate surfaces of the quoin and miter post to which adjustable miter and quoin block assemblies are to be butted against shall be considered machine work and thus covered under section 05055, paragraph titled MACHINE WORK. This surface shall be field machined after erection to be straight to within 0.020" of the lines indicated in the contract both vertically in elevation views and horizontally in plan views regardless of feature size. This surface shall also remain flat to within 0.015" over any given 10 foot length relative to the lines shown on the contract plans regardless of feature size. The end plate shall also maintain at least the minimum as-rolled thickness requirement as defined in ASTM A 6/A 6M for the size plate indicated on the contract plans.

The surfaces of framing elements to which skin plates are to be welded shall not vary from a true plane by more than 3/16 inch. The outside surfaces of skin plates welded to framing members shall not vary from a true plane by more than 3/16 inch. Splices in skin plates shall be located only where shown or approved. In addition to welds specifically indicated on the drawings for nondestructive testing, 15 percent of the welds in the girders, gudgeon pin hood, vertical diaphragms, stiffeners, intercostals, thrust plates, miter posts, quoin posts, seal assemblies, and skin plate of the gate leaf shall receive nondestructive testing. The location of these additional welds for testing shall be as directed by the Contracting Officer. Gate leaf shall be provided complete with quoin and miter contact blocks, miter guide assembly, miter latching device, miter recess latch, pintle assembly, gudgeon anchorage, seal assembly, and other appurtenant components as required for complete installation, specified herein and shown.

2.3.7.2 Embedded Wall Quoin

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Embedded wall quoin shall consist of a welded structural steel frame with concrete anchors, stainless steel base and side plates, and adjustable stainless steel quoin contact block. The embedded wall quoins shall be installed in each of the miter gate monoliths as shown on the drawings. **The embedded wall quoin assembly is not required for the spare gate leaves.**

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2.3.7.3 Adjustable Quoin and Miter Contact Block Assemblies

Adjustable quoin and miter contact assemblies shall consist of stainless steel bars conforming to ASTM A 240 UNS S17400 of the condition and hardness indicated on the contract plans. Contact faces of contact blocks shall be milled at splices to assure watertight joints. Contact blocks shall be provided with adjusting bolts as shown. The contact blocks and spacers shall be machined flat and parallel within 0.010" and machined to a surface finish as shown on the drawings. This may be done in the field after the gates have been assembled.

2.3.7.4 Pintle Assembly

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Pintle assembly shall consist of pintle socket, pintle, pintle bushing and pintle base as shown. Pintle socket shall be of cast nickel-alloy steel. Pintle socket shall be fitted with a bronze pintle bushing that has its concaved surface coated with Thordon HPSXL or approved equal bearing material to form a bearing surface. Pintle Bushing coated bearing surface shall be machined and finished to the bearing materials manufacturer recommended dimensional tolerances and surface finish. Bronze for the pintle bushing shall be the standard alloy for Thordon TRAXL bearings or the manufacturer standard alloy for an approved equal. The contacting surface between the pintle socket and pintle bushing shall be machined by lapping or other approved methods to assure a minimum of 95 percent bearing area contact between the components as determined by testing with carbon paper or other approved coloring. Pintle ball shall be of ASTM A27 Grade 70-40 with bearing surface formed from 300 series stainless steel weld build up with .005" hard chrome plating. Pintle ball shall receive a 16 microinch finish and shall be machined to the manufacturers recommended tolerances for clearances with the coated bearing surface of the pintle bushing. The pintle socket, pintle bushing and pintle ball shall be match-marked when fitted and so erected in the field. Pintle base shall be of ASTM A27 Gd 70-40. **A pintle base is not required for the spare gates.** Bolt holes for attaching pintle socket to gate leaf shall be drilled and reamed after the pintle socket is assembled with gate leaf. Pintle socket shall be connected to the bottom of the lower girder web of the gate leaf with stainless steel bolts.

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2.3.7.5 Gudgeon Anchorage

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Gudgeon anchorage shall consist of **the gudgeon anchorage arms; link plates,** anchor**, link** and gudgeon pins (w/keeper plates); and gudgeon embedded anchorage. Gudgeon anchorage links and gudgeon pin shall be of forged alloy steel conforming to ASTM A 668/A 668M. Gudgeon anchorage links shall be pin connected to the gudgeon embedded anchorage and shall have a threaded section for adjustment of the gate leaf. The threaded section shall have a hexagonal sleeve nut with a jam nut with standard threads at each end of the sleeve nut. The gudgeon embedded anchorage shall consist of a structural steel frame with end-restrained anchor bolts conforming to ASTM A 325.

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2.3.7.6 Seal Assemblies

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Seal assemblies shall consist of rubber seals, stainless steel retainer and spacer bars, and fasteners. Rubber seals shall be continuous over the full length. Seals shall be accurately fitted and drilled for proper installation. Bolt holes shall be drilled in the rubber seals by using prepared templates or the retainer bars as templates. Splices in seals shall be fully molded, develop a minimum tensile strength of 50 percent of the unspliced seal, and occur only at locations shown. All vulcanizing of splices shall be done in the shop. The vulcanized splices between molded corners and straight lengths shall be located as close to the corners as practicable. Splices shall be on a 45 degree bevel related to the "thickness" of the seal. The surfaces of finished splices shall be smooth and free of irregularities. Stainless steel retainer bars shall be field-spliced only where shown and machine-finished after splicing. **Seal**

assemblies for the spare gates shall be fitted and the rubber seals removed and stored in the lock wall galley at McAlpine Lock's existing 1200' chamber.

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2.3.7.7 Appurtenant Items

Sill assemblies, latches and latching devices, bumpers fenders, seal plates and shapes, and other appurtenant items shall conform to details specified herein and Sections 05055 and 05502 and shown on the contract plans except the hydraulic cylinders shown on the gate latching devices. The hydraulic cylinders shall conform to the requirements of section 15010.

2.3.8 Shop Assembly

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Shop assembly requirements for miter gates and appurtenant items shall be as shown and specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Miter gates and appurtenant items shall be assembled completely in the shop, unless otherwise approved by the Contracting Officer, to assure satisfactory field installation. Adjoining components shall be fitted and bolted together to facilitate field connections. The matchmarking of unassembled items shall be carefully preserved until the items are assembled. Mating surfaces and machined surfaces shall be covered with a rust preventive until assembly. Assembled components shall be shop-welded in their final positions as much as delivery and field installation conditions will permit. Rubber seals shall be fitted and drilled to match the seal retainers, match-marked, and removed for shipment. Shop assembly and disassembly work shall be performed in the presence of the Contracting Officer unless otherwise approved by the Contracting Officer. **The presence of the Contracting Officer will not relieve the Contractor of any responsibility under this contract.**

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2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

Tests, Inspections, and Verifications for materials shall conform to the requirements specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS.

2.4.1 Testing of Rubber Seals

The fluorocarbon film of rubber seals shall be tested for adhesion bond in accordance with ASTM D 413 using either the machine method or the deadweight method. A 1 inch long piece of seal shall be cut from the end of the seal which has been masked and subjected to tension at an angle approximately 90 degrees to the rubber surface. There shall be no separation between the fluorocarbon film and the rubber when subjected to the following loads:

THICKNESS OF FLUOROCARBON FILM	MACHINE METHOD AT 2 INCHES PER MINUTE	DEADWEIGHT METHOD
0.030 inch	30 pounds per inch width	30 pounds per inch width
0.060 inch	30 pounds per inch width	30 pounds per inch width

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall conform with the requirements specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Miter gates and appurtenant items shall be assembled for installation in strict accordance with the contract drawings, approved installation drawings, and shop match-markings. Bearing surfaces requiring lubrication shall be thoroughly cleaned and lubricated with an approved lubricant before assembly and installation. Components to be field-welded shall be in correct alignment before welding is commenced.

3.1.1 Embedded Metals

Sill assemblies, seal plates gate latching devices, frames, bases and other embedded metal items required for proper and complete installation shall be accurately installed to the alignment and grade required to ensure accurate fitting and matching of components. Embedded metals shall be given a primer coat of the required paint on all surfaces prior to installation in concrete forms. Anchors for embedded metals shall be installed as shown. Items requiring two concrete pours for installation shall be attached to the embedded anchors after the initial pour, adjusted to the proper alignment, and concreted in place with the second pour. Welded field splices in sealing surfaces of embedded items shall be ground smooth.

3.1.2 Pintle Assembly

Base anchors for the pintle assembly shall be embedded in first-pour concrete. The pintle assembly base plate shall be attached to base anchors, adjusted to the exact elevation and center-to-center distance shown, leveled, blocked rigidly to prevent displacement, and embedded in second-pour concrete. The concrete shall be allowed to set 72 hours and must reach a minimum compressive strength of 3000 psi before loading is applied.

3.1.3 Gudgeon Embedded Anchorage

The gudgeon embedded anchorage, except for anchor bolts and horizontal anchor arms, shall be covered with asphalt saturated preformed strips applied with asphalt cement prior to being embedded in concrete. Anchor bolts shall be coated with asphalt mastic. The gudgeon embedded anchorage shall be aligned, leveled, and blocked rigidly in place to prevent displacement before concrete is placed. Concrete shall be placed in a manner not to damage the preformed strips. Anchor bolts shall be tensioned after the concrete has attained the specified strength.

3.1.4 Embedded Wall Quoin

Wall and side wall anchors for the embedded wall quoin shall be embedded in first-pour concrete such that placement of the embedded wall quoin will produce the proper distances between the pintle assembly center line and embedded wall quoin as indicated on sheet S-305 of the contract drawings. The embedded wall quoin shall be attached to base anchors prior to setting the gate leaf in place. After the gate leaf is set in place and before prestressing the gate leaf diagonals, the embedded wall quoin shall be plumbed and adjusted in relation to the gate leaf adjustable quoin assembly contact block so as to provide for continuous contact between the sealing surfaces of the embedded wall and adjustable quoin assembly contact blocks over the full height of the gate leaf. This adjustment shall be made almost entirely by moving the embedded wall quoin contact block so that the gap for the epoxy filler behind the embedded wall quoin contact block is near the nominal dimension indicated on sheet S-305 of the contract plans. Additionally the extended length of the adjustable quoin block assembly shall remain near a nominal dimension of 8 1/4 inches between the minimum and maximum points of extension as shown on sheet S-307 of the contract drawings. After prestressing of gate leaf diagonals the adjustment of the embedded wall quoin contact block shall be checked. Fine adjustment shall made to the embedded wall quoin contact block as needed. After final adjustments have been made, the embeddedwall quoin shall be anchored firmly and the second-pour concrete shall be placed in the blockout. After final adjustments are made to the adjustable quoin and miter block assemblies when gate leaves are mitered, the epoxy filler shall be placed between the embedded wall quoin contact block and the back plate as indicated on the contract drawing for the entire height of the assembly. After the epoxy filler cures, the adjusting bolts shall be tightened so as to draw the embedded wall quoin contact block into the epoxy filler.

3.1.5 Gate Leaf

Gate leaf components not assembled in the shop shall be assembled in the field as required for installation. All necessary precautions shall be taken to avoid distortion of the gate leaf or any component parts. Special care shall be exercised during installation to prevent any sag of the miter ends of the gate leaf due to compression of blocking or other causes. After the gate leaf has been set in place and the components of gudgeon anchorage are connected to the gate leaf, the gate leaf shall be plumbed and brought into correct position by adjusting of the diagonals and the gudgeon anchorage links.

3.1.5.1 Spare Gate
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The spare gate leaves are to be installed at McAlpine wharf on piers #1 and #2. This area is available for use to erect, assemble and paint the spare gates. The spare gates shall be attached to the embedded gudgeon anchorages and pintle base provided on the piers. The gates shall be plumbed, swung and prestressed while hanging on the piers. The quoin and miter blocks shall be adjusted to achieve full bearing contact while the

gates are mitered on the pier. The rubber seals shall be mounted on the gate to insure proper fit, then the rubber seal shall be removed and stored in the galley at McAlpine Locks.

The gates may be erected against the north side of pier #1 and the downstream side of pier #2. The contractor is responsible for handling and lifting the gate sections during erection. If it is decided that the gate is to be completely fabricated off-site the gates must always be stored in the vertical position. The COE's gate lifter crane may be used to lift the assembled gate leaf on to the pier. Coordination and scheduling the use of the crane must be made-through the Contracting Officers Representative.
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3.1.6 Diagonals

Gate leaf diagonals shall be attached to the gate leaf after the leaf is set in place. Diagonals prestressing shall be performed before the final adjustment of the embedded wall quoin and adjustable quoin and miter block assemblies are made. Prestressing of diagonals shall be as indicated on the contract drawings sheet S-289 and as approved on the prestressing plan developed by the Contractor. The plan for prestressing the diagonals shall describe the method of prestressing, including the materials, connections, rigging, anchorages, and stress measuring equipment. The Contractor shall compile a record of the prestressing operations consisting of the information indicated in the table provided on the drawings, see sheet S-289.

3.1.7 Adjustable Quoin and Miter Block Assemblies

Adjustable quoin and miter block assemblies shall be adjusted to a nominal extension of 8 1/4 inches between the minimum and maximum extensions shown on sheets S-305 and S-307 and S-308B before diagonal prestressing operations. Initial adjustment will require the use of the 1/2 inch spacer blocks shown in the adjustable quoin and miter block assemblies. After prestressing of the diagonals and the embeddedwall quoin has been adjusted and concreted in place and final adjustments made to the gudgeon anchorage links, the adjustable quoin and miter block assemblies shall be adjusted to provide continuous contact over the full height of the gate leaf at both the miter and quoin ends when in the mitered position. After final adjustment, epoxy filler shall be placed into the void between the quoin/spacer contact block and the pintle socket as shown on sheet S-290. After epoxy filler cures the adjusting bolts shall be tightened so as to draw the embedded wall quoin contact block into the epoxy filler. Just prior to the rewatering of the lock chamber adjustable miter and quoin assemblies shall be filled, using grease fittings, with Dupount 111 Valve Lubricant.

3.1.7.1 Placing Epoxy Filler

A field test to determine the indentation hardness of the epoxy filler compound shall be conducted prior to placement. The field test procedures are as follows:

a. Cast a 2 inch cube sample of mixed epoxy filler compound in a mold and cure at room temperature (70 to 80 degrees F) for 24 plus or minus 8 hours.

b. Remove from mold and cut sample to expose interior surface.

c. Sand exposed interior surfaces to remove saw marks and provide a smooth surface.

d. Using a Type D Durometer conforming to ASTM D 2240, measure the hardness across the exposed interior surface, taking a minimum of three readings on each half of the sample. Care must be taken during the durometer reading to insure the spring loaded pin used to penetrate the surface is not in a depressed surface caused by either residual saw marks or an exposed air bubble. The average reading should be at least 85 with no individual reading below 82. If the durometer readings fall below the required minimum values, the material will be rejected.

The manufacturer's instructions for placing the epoxy filler shall be followed explicitly. Special precautions must be taken to prevent leakage of the filler during placement. The complete masses of the metals whose surface areas are to receive the epoxy filler should have a temperature of 60 to 90 degrees F. The epoxy filler shall be kept free from moisture or other foreign materials during mixing and placement for at least 48 hours after placement.

Epoxy filler shall be placed between the embedded wall quoin contact block and back plate as indicated on sheet S-305 of the contract plans. Epoxy filler shall also be placed in the void between the adjustable quoin contact block and the pintle socket as indicated on sheet S-290

3.1.8 Miter Guide

Miter guide shall be installed after the contact blocks have been properly set. The guide bracket and roller bracket shall be mounted on gate leaves with leaves in the mitered position. The roller shall be centered accurately in the saddle of the contact and shall be in full contact with the . Adjustment of the miter guide shall be accomplished by adjusting the guide bracket and roller bracket so that the gap behind the contact for the filler is kept at the nominal dimension. Proper adjustment of the brackets should allow either gate leaf to be mitered or opened without moving the other leaf. After final adjustments have been made, bolt holes shall be drilled in the brackets and gate leaves, brackets shall be bolted securely in place, and filler shall be placed behind the contact .

3.1.9 Painting

Exposed parts of gates and appurtenances except machined surfaces, corrosion-resistant surfaces, surfaces of anchorages embedded in concrete, threadsand other specified surfaces shall be painted as specified in Section 09965 PAINTING: HYDRAULIC STRUCTURES.

3.1.10 Seal Assemblies

Rubber seal assemblies shall be installed after the embedded metal components have been concreted in place and the gate installation, including painting, completed. Rubber seals shall be fastened securely to metal retainers. Before operating the gate(s), a suitable lubricant shall be applied to the rubber seal rubbing plates to protect the rubber.

3.2 CATHODIC PROTECTION SYSTEM

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The cathodic protection system shall conform to Section **13110**.

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3.3 OPERATING MACHINERY

Operating machinery shall conform to Section 15010.

3.4 FIELD TESTS AND INSPECTIONS

3.4.1 Acceptance Trial Operation

After completion of the gate installation, the Contracting Officer will examine the gates for final acceptance. The gates will be examined first to determine whether or not the workmanship conforms to the specification requirements. The Contractor will then be required to operate the gates from the fully-opened to the fully-closed position a sufficient number of times to demonstrate to the Contracting Officer's satisfaction that all parts are functioning properly. The workmanship in the fabrication and installation of gates shall be such that the gates in the closed position will form a watertight barrier across the opening. Required repairs or replacements to correct defects, as determined by the Contracting Officer, shall be made at no cost to the Government. The trial operation shall be repeated after defects are corrected. Prior to final acceptance of the gates, the Contractor shall provide temporary restraints to prevent unauthorized operation of the gates.

3.5 PROTECTION OF FINISHED WORK

Protection of finished work shall conform to the requirements of Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

-- End of Section --

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DIVISION 11 - EQUIPMENT

SECTION 11287

CULVERT VALVES, BULKHEADS, AND BY-PASS PIPING AND VALVES

01/94

-- End of Section Table of Contents --

SECTION 11287

CULVERT VALVES, BULKHEADS, AND BY-PASS PIPING AND VALVES
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1992) Structural Steel
ASTM A 53	(1998) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 126	(1995) Gray Iron Castings for Valves, Flanges and Pipe Fittings
ASTM A 148	(1990) Steel Castings, High-Strength, for Structural Purposes
ASTM A 276	(1998) Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A 325	(1993) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 514	(1994) High Yield Strength Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A 563	(1997) Carbon and Alloy Steel Nuts
ASTM A 668	(1991) Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM B 177	(1993) Practice for Chromium Electroplating on Steel for Engineering Use
ASTM C 109	(1992) Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens)

ASTM C 939	(1987) Flow of Grout for Preplaced-Aggregate Concrete
ASTM C 940	(1989) Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory
ASTM D 395	(1989) Rubber Property - Compression Set
ASTM D 412	(1992) Rubber Property in Tension
ASTM D 413	(1982; R 1988) Rubber Property - Adhesion to Flexible Substrate
ASTM D 471	(1979; R 1991) Rubber Property - Effect of Liquids
ASTM D 572	(1988) Rubber Deterioration by Heat and Oxygen
ASTM D 573	(1998) Rubber Deterioration in an Air Oven
ASTM D 2240	(1991) Rubber Property - Durometer Hardness
ASTM F 436	(1993) Specification for Hardened Steel Washers
ASTM F 593	(1998) Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F 594	(1998) Stainless Steel Nuts
ASTM F 880	(1998) Stainless Steel Socket Set-Screws

ASME INTERNATIONAL (ASME)

ASME B18.2.1	(1996) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(1987; R 1999) Square and Hex Nuts (Inch Series)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75mm Through 1200 mm), for Water and Other Liquids
AWWA C111	(1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

AWWA C115	(1996) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C150	(1996) Thickness Design of Ductile-Iron Pipe
AWWA C504	(1994) Rubber-Seated Butterfly Valves
AWWA C550	(1990) Protective Epoxy Interior Coatings for Valves and Hydrants

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1992) Structural Welding Code - Steel

1.2 UNIT PRICES

The culvert valves, bulkheads, intake screens, sealing diaphragms, and by-pass piping and valves will be measured for payment on the job basis for the satisfactorily completed work. Payment will be made at the contract lump sum price for "Culvert Valves and Maintenance Bulkheads" which price and payment shall constitute full compensation for furnishing, fabricating, painting, delivering, storage, and installing the culvert valves and trunnion girder assemblies including trunnion castings, trunnion pins, maintenance bulkheads and lifting beam assemblies, anchor bolts, cover and skin plates, top, side and bottom seals with appurtenant embedded items (including all seal plates and beams), cathodic protection, testing, and any other incidentals necessary to furnish the culvert valves, maintenance bulkheads, intake screens, sealing diaphragms, and by-pass piping and valves, complete and operable.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. When used, a designation following the "GA" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Data

Epoxy Filler; GA, ED.

Manufacturer's description of epoxy filler shall be submitted for approval 30 days prior to the use of the material in the work.

Grout Admixture; GA, ED.

Manufacturer's description of grout admixture shall be submitted for approval 30 days prior to the use of the material in the work.

Manufactured Units; GA, ED.

Manufacturer's description for all manufactured units shall be submitted for approval 30 days prior to the use of the material in the work.

SD-04 Drawings

Fabrication and Erection; GA, ED.

The Contractor shall submit shop drawings which include: culvert valves, bulkheads, intake screens, sealing diaphragms, seals, setting frames, embedded items, and all appurtenances. Drawings shall show complete details of materials, tolerances, machined surface finishes, connections, proposed welding sequences which clearly differentiate field and shop welds, location and type of nondestructive weld tests, and all details for assembly and erection at the job site as well as details specified in related sections. Any component part or fabricated items inadvertently omitted on the contract drawings shall be detailed on the shop drawings by the Contractor. Shop drawings shall be submitted and approved before fabrication is commenced.

Shop Assembly Drawings; GA, ED.

The Contractor shall submit shop assembly drawings which provide details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

By-Pass Piping and Valves; GA, ED.

Equipment shop drawings and support system detail drawings showing piping systems and appurtenances, such as mechanical joints, valves, local indicators and hangers, including a complete list of equipment and materials. As-built drawings showing pipe anchors and guides, and layout of piping systems relative to other parts of the work including clearances for maintenance and operation.

Delivery Drawings; GA, ED.

Delivery drawings shall provide descriptions of methods for delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damage.

Field Installation Drawings; GA, ED.

Field installation drawings shall provide a detailed description of the field installation procedures. The description shall include the location and method of support of installation and handling equipment; the provisions to be taken to protect concrete and other work during installation; the method of maintaining gate components in correct alignment; and the methods for installing all other appurtenant items.

SD-07 Schedules

Materials; FIO

Materials orders, materials lists and materials shipping bills shall be submitted as specified in Section 05055 METALWORK FABRICATION, MACHINE

WORK, MISCELLANEOUS PROVISIONS.

SD-08 Statements

Welding; GA, ED.

Schedules of welding procedures for structural steel shall be submitted as specified in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

Storage Facilities; GA, ED.

The Contractor shall furnish a detailed description of proposed storage facilities and plan for storage, maintenance, and inspection.

Erecting Engineer Qualifications; GA, ED.

The Contractor shall submit the qualifications of the Erecting Engineer. Included in the qualifications shall be a list of past successfully completed projects, with Corps of Engineers District contacts who can verify the satisfactory erection of these same projects.

SD-09 Reports

Tests, Inspections, and Verifications; FIO.

Certified test reports for material tests shall be submitted showing that the materials comply with the applicable specifications. Reports shall note the specific standards followed in he performance of tests. Test reports shall be submitted for each material shipment and shall be identified with specific lots prior to use in the work.

SD-14 Samples

Materials; GA, ED.

The Contractor shall furnish, upon request, specimens and samples for independent tests and analysis. These specimens and samples shall be properly labeled and prepared for shipment. Additional samples of standard and shop fabricated items shall be furnished; each shall be full-size and complete as required for installation in the work. Approved samples may be installed in the work provided each sample is identified and its location recorded.

SD-18 Records

Materials Disposition; FIO.

System of identification which shows the disposition of specific lots of approved materials and fabricated items in the work shall be submitted before completion of the contract.

Grout Records; GA, ED

Grout mix design, grout admixture test results, and grout design compressive strength test results shall be submitted and approved before grouting commences.

Measurements and Observations; FIO.

The Contractor shall furnish a complete record of all measurements and observations made by the erecting engineer.

SD-19 Operation and Maintenance Manuals

By-Pass Piping and Valves; FIO.

Six copies each of operation and maintenance manuals in indexed booklet form. Operation manuals shall include the manufacturer's name, model number, parts list and brief description of piping equipment such as valves and other appurtenances and their basic operating features. Maintenance manuals shall list routine maintenance procedures and troubleshooting guides for the equipment.

1.4 QUALIFICATION OF WELDERS AND WELDING OPERATORS

Qualification of welders and welding operators shall conform to the requirements of Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

1.5 DELIVERY, STORAGE, AND HANDLING

Materials shall be shipped to the site and handled as recommended by the manufacturer and as approved by the Contracting Officer. Materials and shop-fabricated components shall be shipped, handled, and stored in a manner to prevent permanent deflection, distortion, or other damage. Provisions for delivery shall be as shown on approved delivery drawings. The match-marking of all unassembled items shall be carefully preserved until the items are correctly assembled. The Contractor shall maintain the coating in a manner satisfactory to the Contracting Officer's representative until assembly. Protective wrappings and coverings shall not be removed until immediately prior to assembly or installation. Rubber seals shall be stored in as cool a place as practicable, preferably at 70 degrees F or less; and in no case shall the rubber be stored in the open or exposed to the direct rays of the sun. All rubber shall be stored so as permit free circulation of air about the rubber. Care shall be exercised at all times to keep the rubber free from oils, grease, and other materials which would deteriorate the rubber, and to prevent distortion during handling. The various elements of the culvert valves, bulkheads, and anchorage systems, exclusive of boxed parts and components, shall be stored on wood blocks not less that 8 inches above a base of either washed gravel or crushed stone, two inches thick. The valve hubs and bushings shall be suitably covered by a watertight protective cover to prevent the hubs and bushings from being damaged by dirt, water, or rust. The boxed parts and components shall be stored in a weathertight building. A framework with a plastic film, or any other such expedient or makeshift arrangement, will not be acceptable.

PART 2 PRODUCTS

2.1 MATERIALS

Materials orders, materials lists, and materials shipping bills shall conform with the requirements of Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.1.1 Metals

Structural steel, steel forgings, steel castings, stainless steel, bronze, aluminum-bronze, and other metal materials used for fabrication shall conform to the requirements shown on the drawings and specified herein and in Section 05502 METALS: MISCELLANEOUS, STANDARD ARTICLES, SHOP FABRICATED ITEMS.

2.1.1.1 Structural Steel Shapes

ASTM A 36.

2.1.1.2 Structural Steel Plates

ASTM A 36,or ASTM A 514, Grade F.

2.1.1.3 Steel Castings

ASTM A 148, Grade 80-50.

2.1.1.4 Steel Forgings

ASTM A 668, Class J, carbon content not exceeding 0.35 per cent, and chemical composition which results in satisfactory weldability.

2.1.1.5 Stainless Steel Bars and Shapes

ASTM A 276, UNS S 30400, Condition A, hot-finished or cold-finished, Class C.

2.1.2 Concrete

As specified in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

2.1.3 Concrete Reinforcement

As specified in Section 03201 STEEL BARS AND WELDED WIRE FABRIC FOR CONCRETE REINFORCEMENT FOR CIVIL WORKS.

2.1.4 Premolded Expansion Joint Sheets

As specified in Section 03151 EXPANSION, CONTRACTION, AND CONSTRUCTION JOINTS IN CONCRETE FOR CIVIL WORKS.

2.1.5 Rubber Seals

Rubber seals shall be fluoro-carbon (Teflon) clad rubber seals of the mold type only, shall be compounded of natural rubber, synthetic polyisoprene, or a blend of both, and shall contain reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents, and plasticizers. Physical characteristics of the seals shall meet the following requirements:

PHYSICAL TEST	TEST VALUE	TEST METHOD SPECIFICATION
Tensile Strength	2500 psi (min.)	ASTM D 412
Elongation at Break	450% (min.)	ASTM D 412
300% Modulus	900 psi (min.)	ASTM D 412
Durometer Hardness (Shore Type A)	60 to 70	ASTM D 2240
*Water Absorption	5% by weight (max.)	ASTM D 471
Compression Set	30% (max.)	ASTM D 395
Tensile Strength (after aging 48 hrs)	80% tensile strength (min.)	ASTM D 572 and ASTM D 573

*The "Water Absorption" test shall be performed with distilled water. The washed specimen shall be blotted dry with filter paper or other absorbent material and suspended by means of small glass rods in the oven at a temperature of 70 degrees C plus or minus 2 degrees C for 22 hours plus or minus 1/4 hour. The specimen shall be removed, allowed to cool to room temperature in air, and weighed. The weight shall be recorded to the nearest 1 mg as W1 (W1 is defined in ASTM D 471). The immersion temperature shall be 70 degrees C plus or minus 1 degree C and the duration of immersion shall be 166 hours.

Rubber seals shall have a fluoro-carbon film vulcanized and bonded to the sealing surface of the bulb. The film shall be 0.060 inch thick Huntington Abrasion Resistant fluoro-Carbon Film No. 4508, or equal, and shall have the following physical properties:

Tensile strength ....2,000 psi (min.)

Elongation.......................250 percent (min.)

The outside surface of the bonded film shall be flush with the surface of the rubber seal and shall be free of adhering or bonded rubber. Strips and corner seals shall be molded in lengths suitable for obtaining the finish lengths shown on the drawings and with sufficient excess length to provide test specimens for testing the adequacy of the adhesion bond between the film and bulb of the seal. At one end of each strip or corner seal to be tested, the fluoro-carbon film shall be masked during bonding to prevent a bond for a length sufficient to hold the film securely during testing.

2.1.6 Anti-Seize Agent

Threaded portions of stainless steel nuts and bolts shall be coated with Loctite Nickel Anti-Seize Agent, or approved equal.

2.1.7 Cement for Grout

Cement for grout shall be as specified in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

2.1.8 Grout Admixture

Grout admixture shall be a shrinkage compensating type which produces 2 percent maximum and 10 percent maximum unconfined expansion of the grout when tested in accordance with ASTM C 940, shall not contain chlorides, fluorides, or nitrates and may be dispensed in solid or liquid form. Complete manufacturer's description of the grout admixture shall be submitted for approval.

2.1.9 Epoxy Filler

Epoxy filler shall be an approved epoxy resin formulation with a specific gravity of 1.70 to 1.75, a minimum compressive strength after 72 hours at 70 degrees F of 16,500 psi, and a maximum shrinkage of 0.15 percent. The manufacturer must verify that the material meets or exceeds the specified physical properties.

2.1.10 Ductile Iron Piping System

2.1.10.1 Ductile Iron Pipe

Ductile iron pipe shall conform to AWWA C115 and shall have a design and wall thickness conforming to AWWA C150. Ductile iron pipe shall have a standard asphaltic lining.

2.1.10.2 Ductile Iron Joints

Joints shall have a working pressure rating for liquids equal to the pressure rating of the connected pipe. Joints conforming to AWWA C110 and AWWA C111 shall be used. Gaskets, glands, bolts and nuts shall be furnished in sufficient quantity for the complete assembly of each joint. Dielectric fittings or isolation joints shall be provided between all dissimilar metals. Glands shall be ductile or gray iron with an asphaltic coating. Bolts shall conform to ASME B18.2.1 and nuts shall conform to ASME B18.2.2. Joints shall have bolt holes oriented straddling the vertical centerline of the valves and fittings.

2.1.10.3 Ductile Iron Fittings

Fittings shall be ductile iron AWWA C110. The fittings shall be 250 psig rated. Flanges and flanged fittings shall conform to AWWA C110 and shall be rated for 250 psig service. Materials shall be ductile iron.

2.1.10.4 Corrosion Control

Ductile iron piping shall be coated with the manufacturer's standard asphaltic coating, approximately 2 mil thick, applied to the outside of pipe and fittings.

2.1.11 Pipe Sleeves

ASTM A 53, black.

2.1.12 Suction Strainers

AWWA C110. Strainers shall have a perforation area greater than the area of the pipe.

2.2 MANUFACTURED UNITS

Bolts, nuts, washers, screws and other manufactured units shall conform with the requirements shown on the drawings and specified herein and in Section 05502 METALS: MISCELLANEOUS, STANDARD ARTICLES, SHOP FABRICATED ITEMS.

2.2.1 Bolts, Nuts and Washers

High-strength bolts shall conform to ASTM A 325. Washers for high strength steel bolts shall conform to ASTM F 436. Nuts for high strength steel bolts shall conform to ASTM A 563, Grace C. Stainless steel bolts shall conform to ASTM F 593, Type 304, series 400. Stainless steel nuts and washers shall conform to ASTM F 594, Type 304, series 300. Bolts 1/2-inch and larger shall have hexagon heads. The finished shank of bolts shall be long enough to provide full bearing. Washers for use with bolts shall conform to the requirements specified in the applicable specification for bolts.

2.2.2 Screws

Cap screws shall conform to ASTM F 593, Type 304. Set Screws shall conform to ASTM F 880, Type 304.

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2.2.3 Self-Lubricating Bearings

2.2.3.1 Sleeve and Journal Bearings

Self-lubricating bearings shall be manufactured from a non-metallic material. Bearings shall be SXL high pressure composite bearings as manufactured by Thordon Bearings, Inc., 3225 Mainway, Burlington, Ontario, Canada L7M 1A6, or Feroform T814 bearings produced by HMI Wearing and Bearing Products, 200 North Service Road, West, Unit #1, Suite 303, Oakville, Ontario, Canada, 66M 2V1, +(888) 576-3545, or approved equal.

2.2.3.2 Spherical Bearing

Spherical bearings shall be capable 100 kip loads. Spherical ball shall be fabricated from or coated with a non-metallic self-lubricating material. Outer race shall be bronze or stainless steel. Materials used for bearing construction shall be standard catalog products shown in company literature. Bearings shall be as manufactured by Thordon Bearings, Inc., 3225 Mainway, Burlington, Ontario, Canada L7M 1A6, or by HMI Wearing and

Bearing Products, 200 North Service Road, West, Unit #1, Suite 303, Oakville, Ontario, Canada, 66M 2V1, +(888) 576-3545, or approved equal.
***3**

2.2.4 Chromium Coatings

Chromium coatings shall be applied in conformance with ASTM B 177

2.2.5 Butterfly Valves

2.2.5.1 General Requirements

Valves shall include operator, actuator, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and all other accessories required for a complete operation. The valves shall be suitable for the intended service. Renewable parts are not to be of a lower quality than those specified. Valves shall be the same size as adjoining pipe. Valve ends shall be compatible with adjacent piping system. An operator shall be sized to operate the associated valve for the full range of pressures and velocities. Valves will open by turning counterclockwise. Operators, actuators, and accessories shall be factory mounted.

2.2.5.2 Factory Finish

Valves shall have an epoxy coating in accordance with AWWA C550 unless otherwise specified. The epoxy shall be either a two-part liquid material or a heat-activated (fusion) material except that only a heat-activated material shall apply if a valve coating is specified as "fusion" or "fusion bonded" epoxy. The epoxy coating shall have a minimum 7.0 mils dry film thickness except where it is limited by valve operating tolerances.

2.2.5.3 Butterfly Valves

Butterfly valves, 2 inches and larger, shall have ASTM A 126 cast iron bodies, with AWWA C111 end connections. Valves shall conform to AWWA C504, Class 150. Discs shall be contoured bronze. The valve shafts shall be stainless steel with self-lubricating, corrosion-resistant sleeve type bearings. Valve seats shall be attached to either the valve body or the disc and shall be constructed of chloroprene.

2.2.5.4 Operator

The force in a manual operator shall not exceed 39.3 pounds under any operating condition, including initial breakaway. The operator shall be equipped with gear reduction when force exceeds 39.3 pounds. The operator shall be a self-locking type or shall be equipped with a self-locking device. A position indicator shall be supplied on quarter-turn valves. Worm and gear operators shall be a one-piece design with worm-gears of gear bronze material. Worm shall be hardened alloy steel with the thread ground and polished. Traveling nut type operators shall have threader steel reach rods with an internally threaded bronze or ductile iron nut.

2.2.5.5 Extension Bonnet for Valve Operator

All extension bonnets shall be provided as necessary, complete with stem and accessories applicable to the specific valve and operator.

2.2.5.6 Floor Stand and Extension Stem

A floor stand and extension stem shall be the nonrising, indicating type; complete with stem, coupling, stem guide brackets, and yoke attachment. The stem guide shall be spaced such that stem L/R ratio does not exceed 200. Anchors shall be supplied as required.

2.2.6 Trunnion Pins

Trunnion pins shall be made from forgings conforming to ASTM A 668 and shall have a stainless steel overlay of 0.00625" to 0.125" in thickness. The stainless steel overlay shall be finished smooth and then plated with hard chrome applied in conformance with ASTM B 177.

2.3 GROUT

Grout shall be a mixture of Portland cement specified in paragraph CEMENT FOR GROUT, shrinkage compensating admixture specified in paragraph GROUT ADMIXTURE, and potable water. Final mix proportions shall be based on test results of sample mixtures. The water content of grout shall be the minimum necessary for proper placement but the water-cement ratio shall not exceed 0.50 by weight. The fluidity of grout shall be determined in accordance with ASTM C 939. The efflux time of a grout sample immediately after mixing shall not be less than 11 seconds. The minimum 7-day compressive strength of 2-inch grout cubes molded, cured and tested in accordance with ASTM C 109 shall be 2500 psi.

2.4 FABRICATION

2.4.1 Detail Drawings

Detail drawings, including fabrication drawings, shop assembly drawings, delivery drawings, and field installation drawings, shall conform to the requirements specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.4.1.1 Fabrication Drawings

Fabrication drawings shall show complete details of materials, tolerances, connections, machined surface finishes, and proposed welding sequences which clearly differentiate shop welds and field welds.

2.4.1.2 Shop Assembly Drawings

Shop assembly drawings shall provide details for connecting the adjoining fabricated components in the shop to assure satisfactory field installation.

2.4.1.3 Delivery Drawings

Delivery drawings shall provide descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damages.

2.4.1.4 Field Installation Drawings

Field installation drawings shall provide a detailed description of the field installation procedures. The description shall include the location and method of support of installation and handling equipment; provisions to be taken to protect concrete and other work during installation; method of maintaining components in correct alignment.

2.4.2 Structural Fabrication

Structural fabrication shall conform with the requirements shown on the drawings and specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Components shall be shop-fabricated of the materials specified and shown on the drawings. Dimensional tolerances shall be as specified and shown on the drawings. Splices shall occur only where shown on the drawings or approved by the Contracting Officer. Pin holes shall be bored in components after welding, straightening, stress-relieving, and threading operations are completed. Brackets, eye bar sections, and other components requiring straightening shall be straightened by methods which will not damage the material. Bronze bushings shall be press-fitted with supporting components. Bolt connections, lugs, clips, or other pick-up assembly devices shall be provided for components as shown and required for proper assembly and installation. Provisions shall be made for the installation of appurtenances as required.

2.4.3 Welding

Welding shall conform with the requirements of AWS D1.1, specified herein, and in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Welds shall be of the type shown on the contract drawings and approved detail drawings. Non-destructive testing of welds shall be as specified in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.4.4 Bolted Connections

Bolted connections shall conform with the requirements specified in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.4.5 Machine Work

Machine work shall conform with the requirements specified in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.4.6 Miscellaneous Provisions

Miscellaneous provisions for fabrication shall conform with the requirements specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

2.4.7 Fabrications

2.4.7.1 Valves and Bulkheads

The fabrication of the valves, bulkheads, appurtenant embedded items and valve anchorage systems shall be as specified herein and as shown on the drawings. Metalwork requirements, except as specified herein, shall be as specified in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Components shall be shop fabricated of the materials shown on the drawings and shall be free of kinks, twists, bends, rough spots, projections, laminations, or other deformations. Splices shall occur only where shown on the drawings or approved by the Contracting Officer's representative. Where stress-relieved heat treatment is specified or shown on the drawings, it shall be performed prior to the attachment of appurtenances. Dimensional tolerances shall be as specified and shown on the drawings. The shop and field welds for the culvert valves shall be 100 percent tested by nondestructive examination, unless otherwise shown on the drawings or specified in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Bronze bushings shall be press-fitted with supporting components. Bolt connections, lugs, slips, or other pick-up and assembly devices shall be provided for components as shown and required for proper assembly and installation. Fabrication of culvert valve assemblies and trunnion girder assemblies shall be such that the culvert valve assemblies are interchangeable with each other and that the trunnion beam assemblies are interchangeable with each other.

2.4.7.2 Trunnion Pins

Trunnion pins shall be of alloy steel forging conforming to ASTM A 668 with hard chrome cladding conforming to ASTM B 177 as shown on the drawings. The clad surface shall be machined and the thickness of the cladding after final machining shall be not less than 0.005 inch thick.

2.4.7.3 Trunnion Girders

Trunnion girders shall be structural steel as shown on the drawings.

2.4.7.4 Seal Assemblies

Rubber water seals shall be of molded rubber of the section and size shown on the drawings. The entire seal assembly for each valve and bulkhead shall be fabricated as shown. Extra length shall be provided at the ends of the side and top members to allow for field trimming and erecting. All special sections, angles, and corners shall be factory made, fully molded pieces. Each side seal, top seal, and bottom seal shall be one continuous piece. Bolt holes shall be drilled in the rubber seals by using prepared templates or the retainer bars as templates. Each seal shall be the exact length specified after shrinkage. Splices in seals shall be fully molded, develop a minimum tensile strength of 50 percent of the unspliced seal, and occur only at locations shown on the drawings. All vulcanizing of splices shall be done in the shop. The vulcanized splices between molded corners and straight lengths shall be located as close to the corners as practicable. Splices shall be on a 45 degree bevel related to the "thickness" of the seal. The surfaces of finished splices shall be smooth and free of irregularities.

2.4.7.5 Appurtenant Items

Cable attachment brackets, dogging brackets, side seal plates, sill beams, stop beams and other appurtenant items shall conform to the requirements specified and shown on the drawings. The sealing surfaces of side seal plates and sill beams shall be flush, straight, and free from offsets, warps, twists or other distortions.

2.4.8 Shop Assembly

2.4.8.1 Culvert Valves

All valve seal plates shall be completely erected in the shop. Each seal plate shall be assembled true and square to the dimensions shown on the drawings. Side sealing surfaces shall be in parallel vertical planes which shall be equidistant from the centerline of the assembly. The bottom sealing surface shall be in a horizontal plane which shall be normal to the planes of the side surfaces. All sealing surfaces shall be straight, smooth and free of waves, winds, and warp. Each valve shall be completely erected in the shop including the valve proper, seals, and trunnion assemblies. Final shop assembly and disassembly work shall be performed in the presence of the Erecting Engineer. The presence of the Erecting Engineer will not relieve the Contractor of any responsibility under this contract. Adjoining components shall be fitted and bolted together to facilitate field connections. Assembled components shall be shop-welded in their final positions as much as delivery and field installation conditions will permit. Necessary precautions shall be taken during welding to prevent any distortion of the gates. While erected, each valve and seal plate assembly (into which the valve is to operate) shall be individually checked for dimensions, tolerances, and accuracy of alignment and fit to make sure that the valve and seal assembly will assemble properly. Prior to disassembly, the members of each seal plate shall be match-marked for erection in the field. Rubber seals shall be fitted and drilled to match the bearing bars and clamping bars, match-marked, and removed for shipment. All errors in dimensions, tolerances and alignment shall be satisfactorily corrected before the valves are shipped from the shop. Trunnion assemblies and seals shall be dismantled from the valves for shipment. Each valve and its trunnion assemblies and seals, and the seal plate assembly to which the valve has been fitted, shall be match-marked for field erection. Parts damaged in shipment, handling, or erection shall be repaired or replaced as directed by the Contracting Officer at no cost to the Government.

2.4.8.2 Bulkheads

The completed bulkheads, pickup frame and guide frames shall be checked for dimensions, tolerances, and accuracy of alignment in the shop. Each bulkhead and the pickup frame shall be tested in the shop in the presence of the Contacting Officer or his designated representative to determine that the bulkhead hangs plumb. Tests shall include lifting each of the bulkhead sections a sufficient number of times to demonstrate that the hooks engage smoothly and freely at various positions of the frame and bulkhead, and that it is suitable for the performance of the work intended. Any errors discovered shall be corrected to the satisfaction of the Contracting Officer. Each of the bulkheads and the pickup frame shall be assembled as complete units.

2.4.9 Field Erection

The Contractor shall provide all falsework, temporary supports, and other items necessary for the proper erection of the valves and appurtenant items. Provisions shall be made to insure that heavy handling and erection equipment is not placed directly on the lock without adequate protection against damage to the concrete.

2.5 TESTS, INSPECTIONS, AND VERIFICATIONS

Tests, inspections, and verifications for materials shall conform to the requirements specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS.

2.5.1 Testing of Rubber Seals

The fluoro-carbon film of rubber seals shall be tested for adhesion bond in accordance with ASTM D 413 using either the machine method or the deadweight method. A one inch long piece of seal shall be cut from the end of the seal which has been masked and subjected to tension at an angle approximately 90 degrees to the rubber surface. There shall be no separation between the fluoro-carbon film and the rubber when subjected to the following loads:

THICKNESS OF FLOURO-CARBON FILM	MACHINE METHOD AT 2 INCHES PER MINUTE	DEADWEIGHT METHOD
0.060	30 pounds per inch width	30 pounds per inch width

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall conform with the requirements specified herein and in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Gates and appurtenant items shall be assembled for installation in strict accordance with the contract drawings, approved installation drawings, and shop match-markings. Bearing surfaces requiring lubrication shall be thoroughly cleaned and lubricated with an approved lubricant before assembly and installation. Components to be field-welded shall be in correct alignment before welding is commenced.

3.1.1 Embedded Metals

Seal shapes, seal plates, frames, bases and other embedded metal items required for proper and complete installation shall be accurately installed to the alignment and grade required to ensure accurate fitting and matching of components. Embedded metals shall be given a primer coat of the required paint on all surfaces prior to installation in concrete forms. Anchors for embedded metals shall be installed as shown. Items requiring two concrete pours for installation shall be attached to the embedded anchors after the initial pour, adjusted to the proper alignment, and concreted in place with the second pour. Welded field splices in sealing surfaces of embedded items shall be ground smooth.

3.1.2 Trunnion Girders

Trunnion girders for each valve shall be set at their correct locations in the culverts with the surfaces level and normal to the centerline of the culvert. The trunnion anchorage assembly shall not be fixed permanently in place until all seals have been carefully set and trial lift of each valve made to demonstrate correct alignment of parts throughout the entire travel of the valves. After completion of adjustments and the placing of second-placement concrete, the Contractor shall proceed with placement of epoxy fill between the plates in the trunnion girder anchorage assembly.

3.1.3 Culvert Valves

The Contractor, in installing the lock culvert valves, shall exercise every precaution to avoid distorting them in any way. Each valve shall be set in the culvert and adjusted with the trunnion bearings in their theoretical position with the trunnion level and the bottom sealing edge of the valve accurately fitted to the contact surface of the bottom sill plate when the valve is seated on the culvert floor. Adjusting bolts shall be provided at the anchorages for use in making the necessary adjustments. The location of the anchorages when finally adjusted shall be such as to provide a positive and continuous contact between the top seal while the valve is seated on the sill plate. The top, side, and bottom sealing members shall not be grouted in place until all adjustments for trueness of the valve in the lateral, longitudinal, and horizontal planes are completed and all seals have been carefully set and trial lifts of each made to demonstrate the correct alignment of all parts throughout the entire travel of the culvert valves. Prior to erection, the bearing surfaces of the trunnion bearings shall be cleaned thoroughly, and after the installation is complete, and before trial operation and tests are made, the trunnion bearings shall be lubricated with an extreme pressure lubricant suitable for the purpose. The lubricant shall be applied through the permanent lubrication fittings.

3.1.4 Appurtenant Items

Side seal plates, sill beams, stop beams and other items to be embedded in second-pour concrete shall be attached to anchors, aligned, leveled and rigidly blocked to prevent displacement during the placement of concrete. Side seal plates shall be aligned in planes normal to the axis of rotation of the gates and shall be checked before being embedded in concrete to ensure that they do not vary more than 3/32-inch from the established alignment in an arc length of 12 feet. Welded field splices in exposed metals shall be ground smooth to assure proper sealing. Metal supports for rubber seals shall be continuous and free of waves, winds and distortions. Rubber seals shall be installed after the gate painting operations have been completed. Seals shall be adjusted after installation so that they are slightly compressed in the closed, unwatered condition to prevent excessive depression and wear in the closed, watered condition.

3.1.5 Seal Plate Assemblies

Anchor bolts to be set in concrete shall be firmly and securely fastened in place. The seal plates shall be assembled, set in the recesses on the anchor bolts, and adjusted to exact position by means of adjusting nuts. Such bracing and supports as may be necessary to hold and maintain the liners in the proper position during placement of the concrete in the recesses shall be furnished and installed by the Contractor. All dimensions shown on the drawings shall be rigidly adhered to. The installation shall comply with the following conditions:

(1) Each seal plate shall be normal to the centerline of the culvert and in correct relation to the centerline of the trunnion.

(2) The top and bottom seal members shall be level and at the elevation shown on the drawings.

(3) Side seal members shall be in correct relation to the side seals on the culvert valve.

(4) The contact seal surfaces shall be plumb, in parallel planes and equidistant from the centerline of the culvert.

Each seal shall be set true to line, and adjusted to make continuous contact throughout its entire length. The side seal shall be set and adjusted to give the rubber seals a slight initial compression, 1/16-inch to 1/8-inch, against the sealing surface so that the seals will be watertight.

3.1.6 Side Seal Plates

Side seal plates shall be of welded construction and shall be fabricated as shown on the drawings. The seal plates and accessories shall be installed in blockouts, or as otherwise provided in the lock walls. They shall be carefully fabricated and aligned in planes normal to the axis of rotation of the valves, so that the completed embedded assembly shall be free from offsets, warps, twists, or other distortions.

3.1.7 Sill Plates

Sill plates shall be fabricated as shown on the drawings and shall be installed in blockouts, or as otherwise provided in the culvert floors. They shall be aligned to provide smooth surfaces free from offsets, waviness, warps, twists, or other distortions.

3.1.8 Threaded Connections

Threaded connections shall be coated with Loctite Nickel Anti-Seize Agent, or approved equal.

3.1.9 Second-Pour, High-Strength Concrete and Concrete Grout Fills

The second-pour, high-strength concrete fills and the concrete grout fills shall be as shown on the drawings and as specified in Section 03301 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.1.10 Painting

Exposed parts of gates and appurtenances, except machined surfaces, stainless steel surfaces, surfaces of anchorages embedded in concrete, cathodic protection system anodes, and other specified surfaces shall be painted as specified in Section 09965 PAINTING: HYDRAULIC STRUCTURES.

3.1.11 Seal Assemblies

Rubber seal assemblies shall be installed after the embedded metal components have been concreted in place and the gate installation, including painting, completed. Rubber seals shall be fastened securely to metal retainers. Before operating the gates, a suitable lubricant shall be applied to the rubber seal rubbing plates to protect the rubber.

3.1.12 By-Pass Piping

Pipe and equipment openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage. Pipe and fittings shall be inspected before piping is installed. The Contractor shall clean the ends of pipes thoroughly, remove foreign matter and dirt from inside of pipes, and keep piping clean during and after installation. The Contractor shall repair damaged coating areas in the field with material equal to the original coating. The Contractor shall not install damaged piping materials. Impact expansion (hammer and explosive charge drive-type) anchors and fastener systems are not acceptable. Lead shields, plastic or fiber inserts, and drilled-in plastic sleeve/nail drive systems are also not acceptable. Pipe flanges shall be set level, plumb, and aligned. Flanged fittings shall be installed true and perpendicular to the axis of the pipe. The bolt holes shall be concentric to the centerline of the pipe. Following assembly and testing, and prior to final acceptance, the by-pass piping systems shall be flushed with water to remove accumulated construction debris and other foreign matter. The piping shall be flushed until all foreign matter is removed from the pipeline. The Contractor shall provide all hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water.

3.1.13 Butterfly Valves

Valves shall be located in accordance with the contract drawings. Flanged valve bolt holes shall be installed so as to straddle the vertical centerline of pipe. Flanged faces shall be cleaned prior to inserting the gasket and bolts, and then the nuts shall be tightened progressively and uniformly. Threaded ends shall have the threads cleaned by wire brushing or swabbing prior to installation. The operating stem shall be installed in a vertical position. Valves may be tested while testing pipelines, or as a separate step. It shall be demonstrated that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other. The Contractor shall count and record the number of turns required to open and close each valve, and account for any discrepancies with manufacturer's data.

3.2 CATHODIC PROTECTION SYSTEM

The cathodic protection system for the culvert valves shall conform to Section 13100 CATHODIC PROTECTION SYSTEM (Sacrificial Anode).

3.3 OPERATING MACHINERY

Except as specified herein for the by-pass piping and valves, operating machinery shall conform to Section 15010 Hydraulic Power Systems for Civil Works Structures.

3.4 FIELD TESTS AND INSPECTIONS

3.4.1 Culvert Valves

After erection, each valve shall be tested in the dry by raising and lowering it throughout its complete range of travel, by means of its operating machinery or by other method approved by the Contracting Officer, a sufficient number of times to satisfactorily demonstrate that it complies with the specification requirements. Before operating the valves in the dry, a suitable lubricant shall be applied to the side seal rubbing plates to protect the rubber against testing in the dry. Upon completion of each dry test run, the rubber seals shall be cleaned of the lubricant. No lateral sway shall occur while raising and lowering the valves. The valves shall move smoothly and without binding throughout their range of travel. The Contractor shall then operate each valve using available headwater and tailwater from the fully open to the fully closed position a sufficient number of times to demonstrate to the Contracting Officer that all parts are functioning properly. Any and all defects disclosed during the above examination and trial operations shall be corrected by the Contractor and satisfactory retests shall be made.

3.4.2 Bulkheads

Each bulkhead section shall be raised and lowered throughout its entire length of travel in a preselected bulkhead recess to demonstrate that they seat correctly against the seal plates and against each other, and that engagement of the pickup frame can be easily accomplished. Upon completion of the previous tests, one or more of the bulkheads shall be tested as specified above in each of the remaining bulkhead recesses to demonstrate interchangeability of the bulkheads. Each bulkhead shall be lowered to the bottom of one of the recesses at the valve where it will be stored and and a stream of water from a hose, with a pressure of 60 psi at the nozzle, played against the surface of the skin plate and seals. Any leaks through the bulkhead and any leaks at the seals which, in the opinion of the Contracting Officer would not automatically be stopped by an unbalanced water pressure against the bulkhead, shall be corrected by the Contractor in a manner acceptable to the Contracting Officer at no additional cost to the Government. The Contractor shall furnish the equipment required for the testing. Tests shall be conducted by and at the expense of the Contractor, in the presence of the Contracting Officer or his designated representative. Upon completion of the tests and adjustments, each bulkhead section shall be placed on its suspender assembly as directed.

3.5 PROTECTION OF FINISHED WORK

Protection of finished work shall conform to the requirements of Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15010

HYDRAULIC POWER SYSTEMS FOR CIVIL WORKS STRUCTURES

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SECTION 15010

HYDRAULIC POWER SYSTEMS FOR CIVIL WORKS STRUCTURES
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI 70	(2002) National Electrical Code
ANSI T2.24.1	(2000) Hydraulic Fluid Power - Systems Standard for Stationary Industrial Machinery First Edition
ANSI T3.16.2 R1	(1997) Hydraulic Fluid Power - Design for Nonintegral Industrial Reservoirs
ANSI T3.16.3	(1997; R1) Hydraulic Fluid Power - Requirements for Nonintegral Industrial Power Units
ANSI B93.7	(1986M) HYDRAULIC FLUID POWER - VALVES - MOUNTING INTERFACES

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 182/A 182M	(2001) Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A 193/A 193M	(2001a) Alloy-Steel and Stainless Steel Bolting Materials For High-Temperature Service
ASTM A 194/A 194M	(2001a) Carbon and Alloy Steel Nuts for Bolts For High-Pressure and High-Temperature Service
ASTM A 312/A 312M	(2001) Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A 325	(2001) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM A 563	(2000) STANDARD SPECIFICATION FOR CARBON AND ALLOY STEEL NUTS
ASTM A 564/A 564M	(2001) Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
ASTM A 659/A 659M	(1997) Steel, Carbon (0.16 Maximum to 0.25 Maximum Percent), Hot-Rolled Sheet and Strip, Commercial Quality
ASTM A 789/A 789M	(2001a) Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service
ASTM B 177	(2001) Chromium Electroplating on Steel for Engineering Use
*1 ASTM D 92	(2001) STANDARD TEST METHOD FOR FLASH AND FIRE POINTS BY CLEVELAND OPEN CUP
ASTM D 97	(1996a) STANDARD TEST METHOD FOR POUR POINT OF PETROLEUM PRODUCTS
ASTM D 665	(1999) TEST METHOD FOR RUST-PREVENTION CHARACTERISTICS OF INHIBITED MINERAL OIL IN THE PRESENCE OF WATER
ASTM D 892	(2001) STANDARD TEST METHOD FOR FOAMING CHARACTERISTICS OF LUBRICATING OILS
ASTM D 943	(1999)STANDARD TEST METHOD FOR OXIDATION CHARACTERISTICS OF INHIBITED MINERAL OILS
ASTM D 1401	(1998) STANDARD TEST METHOD FOR WATER SEPARABILITY OF PETROLEUM OILS AND SYNTHETIC FLUIDS *1
ASTM D 3951	(1998) Commercial Packaging
ASTM F 436	(1993) STANDARD SPECIFICATION FOR HARDENED STEEL WASHERS
ASTM F 844	(2000) Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM G 85	(1998) Modified Salt Spray (Fog) Testing

ASME INTERNATIONAL (ASME)

ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B31.1	(1998; R 2000) Power Piping
ASME B36.19M	(1985; R 1994) Stainless Steel Pipe
ASME B40.100	(1998) Pressure Gauges And Gauge Attachments
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Base Coverage
ASME Y32.10	(1967; R 1994) Graphical Symbols for Fluid Power Diagrams

INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC 60529	DEGREES OF PROTECTION PROVIDED BY ENCLOSURES (IP CODE)

INTERNATIONAL ORGANIZATION FOT STANDARDIZATION
*1

ISO 1219	(1991) FLUID POWER SYSTEMS AND COMPONENTS - GRAPHIC SYMBOLS AND CIRCUIT DIAGRAMS
ISO 2941	(1974) HYDRAULIC FLUID POWER - FILTER ELEMENTS - VERIFICATION OF COLLAPSE/BURST RESISTANCE
ISO 2942	(1994) HYDRAULIC FLUID POWER - FILTER ELEMENTS - VERIFICATION OF FABRICATION INTEGRITY AND DETERMINATION OF THE FIRST BUBBLE POINT *1
ISO 2943	(1998)HYDRAULIC FLUID POWER - FILTER ELEMENTS - VERIFICATION OF MATERIAL COMPATIBILITY WITH FLUIDS
ISO 4406	HYDRAULIC FLUID POWER - FLUIDS - METHOD FOR CODING
*1 ISO 4572	(1981) HYDRAULIC FLUID POWER-FILTERS-MULTI-PASS METHOD *1

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2001) Industrial Control and Systems
NEMA ICS 2	(2000) Industrial Control and Systems Controllers, Contactors, and Overhead Relays Rated Not More Than 2000 Volts AC

	or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems Enclosures

NATIONAL FLUID POWER ASSOCIATION (NFPA)

NFPA B93.19M	(1972; R 1993) Hydraulic Fluid Power - Particulate Contamination Analysis - Extraction of Fluid Samples from Lines of an Operating System

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE ARP 598B	(1986; R 1991) Determination of Particulate Contamination in Liquids by the Particle Count Method
SAE J518	(1993) HYDRAULIC FLANGED TUBE, PIPE, AND HOSE CONNECTIONS, FOUR-BOLT SPLIT FLANGE TYPE
SAE J1453	FITTING - O-RING FACE SEAL
SAE J1926/1	(1993) CONNECTIONS FOR GENERAL USE AND FLUID POWER-PORTS AND STUD ENDS WITH ISO 725 THREADS AND O-RING SEALING - PART 1: THREADED PORT WITH O-RING SEAL IN TRUNCATED HOUSING

UNDERWRITERS LABORATORIES (UL)

UL 50	(1995; Rev Aug 1997) Enclosures for Electrical Equipment

1.2 PAYMENT

Payment will be made for costs associated with the complete hydraulic power system as specified herein. Payment shall be made for bid item "Hydraulic Power System".

1.3 SYSTEM DESCRIPTION

*1

The work covered by this section of the specifications consists of detailed requirements for the design, fabrication, shop assembly, testing, delivery, storage and installation of fully functioning hydraulic power system for operation of the culvert (filling and emptying) valves, miter gate leaves, and miter gate latches as shown in the contract drawings. Basic components of the hydraulic power system include hydraulic power units, hydraulic cylinders, control valving and valve manifolds as specified herein and shown on the contract drawings. The following appurtenant items shall be provided as specified herein, to produce the hydraulic power system: All

hydraulic power piping, fittings, valves and hoses; Electrical enclosures, conduits, wiring, etc. to connect the basic hydraulic components to the PLC and Manual Control Systems; Pressure transducers and transmitters, pressure gauges and pressure snubbers; Hydraulic fluid; Portable filtering system; Pipe hangers, miscellaneous nuts and bolts; Spare parts as identified herein; Any additional items not identified but required for the proper function of the selected hydraulic components. The Prime Contractor shall be responsible for the coordination and communication between electrical, mechanical, controls and hydraulic equipment sub-contractors.
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1.4 SUBMITTALS

All dimensions and ratings for submittals shall be given in United States Customary System (USCS) of units. Submittals not using USCS will not be approved. Submittals made that reference standards other than those listed in the paragraph titled "REFERENCES" will not be approved. Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Data

HYDRAULIC POWER SYSTEM COMPONENTS; GA, ED. Electrical Equipment; GA, ED.

Submit manufacturer's catalog data and descriptive literature for all standard equipment and products to be incorporated in the work, including all materials and equipment specified in paragraphs HYDARUALIC POWER SYSTEM COMPONENTS and ELECTRICAL EQUIPMENT. This data shall include specifications and assembly drawings showing sizes, ratings, parts and material lists, overall dimensions, and mounting dimensions.

System Description; GA, ED. Design and Performance Requirements; GA, ED.

Submit system description and design computations for all items which are to be designed by the Contractor.

Shop Assembly and Testing; GA, ED.

Submit procedures for shop testing for all testing outlined in paragraph SHOP ASSEMBLY AND TESTING.

*1
Cleaning and Flushing Procedure; GA, ED.
*1

Submit procedures for field cleaning and flushing as outlined in paragraph CLEANING AND FLUSHING THE SYSTEM. Submit a detailed field cleaning procedure not less than 30 days before start of cleaning operations.

Field Testing; GA, ED.

Submit procedures for field testing as specified in paragraph FIELD TESTING. Submit proposed testing program at least 4 weeks prior to the first scheduled test to ensure agreement as to personnel required and scope of the testing program.

SD-04 Drawings

Schematic and Drawings; GA, ED.

Submit schematic and drawings as specified.

SD-09 Reports

Shop Tests; GA, ED. Field Tests; GA, ED.

Submit operational test reports for all required shop testing and testing of the equipment after installation.

Piston Rods; GA, ED.

Submit certified test report of the corrosion resistant test on ceramic coating as specified in paragraph(s) CYLINDER RODS .

SD-19 Operation and Maintenance Manuals

Operation and Maintenance; GA, ED.

Operation and maintenance manuals shall be furnished in accordance with Section 01800.

1.5 DESIGN AND PERFORMANCE REQUIREMENTS

1.5.1 General

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The contract drawings indicate the arrangement of the hydraulic power system for operating the culvert (filling and emptying) valves, miter gates and miter gate latches . The contract drawings show routing of piping for the hydraulic power system and the clearances necessitated by the structure or other equipment, maximum overall dimensions, and other pertinent features. The hydraulic power system shall be designed in conformance with ANSI T2.24.1, and the following criteria.

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1.5.2 Design Parameters

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The hydraulic power system shall consist of four hydraulic power units, four miter gate cylinders, four culvert valve cylinders, eight miter gate latch cylinders, various valve manifolds and control valves plus spare parts as identified herein. Each hydraulic power unit shall operate one miter gate leaf and two miter gate latches. Hydraulic power units in control buildings "A" and "B" shall additionally operate one culvert (filling) valve each. Hydraulic power unit in control building "C" shall additionally operate two culvert (emptying) valves. Drawing M-31 in the contract plans show functions and basic features required of the hydraulic power system. The hydraulic power system shall be capable of operating at 3000 psi. The system shall also be capable of withstanding intermittent pressure spikes of up to 5000 psi.

Drawings M-22 through M-28 show the hydraulic actuators required for the project. The contractor is required to design and supply all mountings, brackets, bearings, etc., shown and not shown, to completely install the approved hydraulic equipment. Actuators, Hydraulic Power Units and Valve Manifolds shall fit in the space constraints shown in the contract plans. Hydraulic cylinders shall be able to withstand submergence in the river as follows. Culvert valve cylinders shall be capable of operating when submerged to a depth of 18 feet without the intrusion of water. Culvert valve cylinders shall prevent the intrusion of water to a depth of 35 feet when not operating. Miter gate cylinders shall be capable of operating when submerged to a depth of 3 feet without the intrusion of water. Miter gate cylinders shall prevent the intrusion of water to a depth of 23 feet when not operating. Miter gate latch cylinders shall be capable of operating when submerged to a depth of 9 feet without the intrusion of water. Miter gate latch cylinders shall prevent the intrusion of water to a depth of 26 feet when not operating.

Hydraulic power system shall be capable of functioning under two separate control systems, PLC (semi-automatic) System and Hard Wired Backup (manual) System, as specified herein and Section 16900 CONTROL AND INSTRUMENTATION, and shown on the contract plans. The hydraulic power system will cycle as described in Section 16900 CONTROL AND INSTRUMENTATION. Complete operating parameters are tabulated on sheets M-24 and M-25, and noted on M-31 in the contract drawings. The hydraulic system shall be capable of continuously reporting fluid pressure, temperature, and actuator position to the control systems. The hydraulic system shall be capable of reporting alarm conditions for fluid level, high fluid pressure, high fluid temperature and contaminated filter. The principal design parameters for the hydraulic power system are as follows:

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a. Miter Gate Leaf: Hydraulic system, when signaled by either control system shall be capable of opening a miter gate leaf against a 202 kip load and closing the gate leaf against a 195 kip load. The hydraulic system shall be capable of holding a miter gate leaf in place when experiencing loads between 202 kips and 387 kips. When a miter gate leaf is loaded in excess of 387 kips the hydraulic system shall allow it to move until the force on the leaf decreases below 387 kips. Between periods of operation, the hydraulic system shall lock the leaf in position as follows. The miter gate leaf shall not drift from its point of rest unless a force in excess of 387 kips is applied to the gate leaf. If a force in excess of 387 kips is applied to a gate leaf, the hydraulic system shall allow it to move until the force on the leaf decreases below 387 kips.

1. PLC Control: The hydraulic system, when controlled by the PLC system, shall operate as follows. The hydraulic system shall accelerate the miter gate leaf from the recess position (open) or the miter position (closed) at a constant rate until the hydraulic cylinder has stroked a distance of 0.96 feet. At that point the hydraulic cylinder shall extend or retract at a constant velocity for 15.31 feet. When the cylinder reaches 16.27 feet of stroke, the hydraulic system shall decelerate the the hydraulic cylinder at a constant rate until the cylinder reaches the end of its stroke. Operating speeds will vary depending on the upper and

lower pool elevations. Charts on sheet M-25 tabulates operating cycles at normal and maximum pool elevations.

2. Hard Wired Backup Control: The hydraulic system, when controlled manually (Hard Wired Backup Control), shall operate as follows. The operator shall have a choice of two speeds and direction for the hydraulic cylinder. The hydraulic cylinder shall extend or retract in response to the operators command. The hydraulic cylinder shall open or close the miter gate leaf at either high (5 feet/min) speed or low (2.5 feet/min) speed in response to the operators command. The stated operating speeds are for normal operating pool elevations and miter gate submergence; Upstream miter gate, normal pool el. 420, submergence 53 feet, Downstream miter gate, normal pool el. 383, submergence 16 feet. At higher pool elevations operating speeds shall decrease due to increased loading on the miter gates.

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b. Culvert (Filling/Emptying) Valve: Hydraulic system, when signaled by either control system, shall be capable of opening either one or two culvert valve(s) against a 100 kip load. The hydraulic system shall be capable of holding a culvert valve in a raised position without drifting down.

1. PLC Controlled: The hydraulic system, when controlled by the PLC system, shall operate as shown on sheet M-24 in the contract drawings.

2. Hard Wired Backup Controlled: The hydraulic system, when controlled manually, shall operate as follows. The operator shall have the choice of direction for the hydraulic cylinder. The hydraulic cylinder shall extend or retract in response to the operators command. The hydraulic cylinder shall open or close the culvert valve at 2 feet/min.

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c. Miter Gate Latches: Hydraulic system, when signaled by either control system, shall be capable of raising or lowering miter gate latches. Gate latches shall fully stroke in one direction in 4 seconds. The hydraulic system shall be capable of holding the miter gate latches in the up position without latches drifting down.

*1

1.5.3 Allowable Stresses

The hydraulic cylinders, including trunnions, cardanic ring, clevis connection, mountings and brackets shall be designed to withstand the maximum operating pressure in the system with a factor of safety of 5 based on the ultimate strength of the material for normal operating conditions. Allowable stress for overload conditions shall be 75 percent of the yield strength of the material. A factor of safety of 2.5 shall be applied to the compression load when designing the hydraulic cylinders to resist buckling. Stress concentration factors shall be used where applicable. Reduction of allowable stresses to compensate for repeated cycles of loading is not required.

1.5.4 Connections

1.5.4.1 Pinned Connections

Pinned hydraulic cylinder connections for field assembly shall be designed as shown in the contract drawings.

1.5.4.2 Shop Connections

Shop connections shall be designed for assembly by means of welding or by bolting.

1.5.4.3 Metal Work Fabrication and Welded Connections
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Design of metalwork fabrication and their welded connections, other than pressure vessels and pressure piping, shall be in accordance Section 05055 METALWORK FABRICATION, MACHINE WORK, AND MISCELLANEOUS PROVISIONS. Hydraulic cylinders shall be welded in accordance with ASME BPV VIII Div 1, Section VIII. Piping shall be welded in accordance with ASME B31.1 and Section 05093 WELDING PRESSURE PIPING. *1

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Packaging

The hydraulic power systems shall not be prepared for shipment until they have been inspected and accepted for shipment at origin by the Contracting Officer or his authorized representative, unless inspection has been waived in writing. Each hydraulic power system or subassembly shall be shipped completely assembled. The subassemblies shall be defined as the following:

a. Hydraulic cylinders

b. Hydraulic power units

c. Piping assemblies

d. Hydraulic Valve Manifolds
*1
The subassemblies shall be provided with adequate protective pads, supports, and blocking and shall be securely restrained to prevent distortion or **damage in transit.** Piping ports and connections shall be provided with plugs or caps to prevent damage and contamination during transit. Any loss or damage during shipment, including damage to the painted surfaces, will be considered the responsibility of the Contractor, and shall be replaced or repaired without cost to the Government. All accessories and spare parts shall be packed separately in containers plainly marked "ACCESSORIES ONLY," and "SPARE PARTS ONLY." A packing list, listing the contents of each container, shall be placed in a moisture-proof envelope and securely fastened to the outside of the container. Standard commercial packaging in accordance with ASTM D 3951 will be acceptable except where a different method or standard of packaging is specified.
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1.6.2 Shipping, Preservation, and Storage

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Prior to shipment the hydraulic cylinders shall be filled with the specified hydraulic fluid and the piping connections sealed. Packing, crating, cradles, etc., necessary to ensure safe shipment are the responsibility of the Contractor. Machined surfaces shall be adequately protected from corrosion and physical damage. Provisions shall be made with external shipping devices to prevent damage to the cylinder and piston rod resulting from the rod flexing up and down in the cylinder during transport. Internal rod supports are not acceptable. The Contractor shall submit his proposal for controlling movement of the piston rod for approval. Equipment delivered and placed in storage shall be stored with protection from the weather, humidity, temperature variation, dirt and dust, or other contaminants. The contractor shall provide individual storage frames on-site for each cylinder. The storage frames will hang the hydraulic cylinders in a vertical position with the rod end of the cylinders pointing down. All the storage frames shall become the property of the government. The contractor will retain ownership of all hydraulic power systems equipment until installed into the lock, fully functional with the control systems and accepted by the government.

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1.7 PROJECT/SITE CONDITIONS

The Contractor shall visit the site to thoroughly familiarize himself with all details of the work and working conditions, to verify dimensions in the field, and he shall then advise the Contracting Officer of any discrepancies prior to performing any work. The General Contractor shall be specifically responsible for the coordination and proper relation of the work to the structure and work of all trades.

1.8 WARRANTY

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All equipment shall be guaranteed for a period of 2 years from the date of acceptance. Replacement parts shall be guaranteed for 1 year from date of replacement. Warranty shall be against defective materials, design, and workmanship. In cases where the equipment manufacturer's advertised minimum guarantee is in excess of 2 years, it shall remain in force for its full period. Upon receipt of notice from the Government of failure of any of the parts during the warranty period, new replacement parts shall be furnished and installed promptly at no additional cost to the Government in a timely manner.

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1.9 OPERATION AND MAINTENANCE INSTRUCTIONS

The Contractor shall furnish 6 complete sets of instructions containing the manufacturer's operation and maintenance instructions for each piece of equipment to the Contracting Officer in accordance with Section 01800 and as follow. . Each set shall be permanently bound and shall have a hard cover. One complete set shall be furnished prior to field testing and the remaining sets shall be furnished before the contract is completed. The following identification shall be inscribed on the covers: "OPERATING AND MAINTENANCE INSTRUCTIONS," title of the project, location of the project, the name of the Contractor, and the contract number. A flysheet shall be placed before instructions covering each subject. The instruction sheets shall be approximately 8 1/2 by 11 inches, with large sheets of drawings folded in. The instructions shall include, but not be limited to, the following:

a. A cross-section drawing of the hydraulic cylinder with parts list.

b. A system layout drawing showing the piping, valves, and controls.

c. A system hydraulic schematic.

d. Electrical wiring and control diagrams.

e. Operating and maintenance instructions.

f. Manufacturer's bulletins, catalog cuts, and descriptive data.

g. Parts lists and recommended spare parts.

h. Handling instructions and weight of cylinders, power units, valve manifolds.

The Operation and Maintenance (O&M) Manual shall contain all information which may be needed or useful for operation, maintenance, repair, dismantling or assembling, and for identification of parts for ordering replacements. The manual will be subject to approval.

1.10 SCHEMATIC AND DRAWINGS

Contractor shall submit each of the following in conformance with ANSI T2.24.1.

1.10.1 Preliminary Drawings

Preliminary drawings shall be of sufficient detail and content to verify that the form and function of the hydraulic power system is consistent with the design parameters.

1.10.2 Shop Drawings

Detailed shop drawings shall include fabrication, shop assembly, delivery, and field installation drawings. Any component part of fabricated items omitted from the contract drawings shall be detailed on the shop drawings.

1.10.3 Fabrication Drawings

Fabrication drawings shall be provided for all mechanical and structural parts or components except those which are of standard manufacture. The drawings shall show complete details of materials, tolerances, machined surface finishes, connections, and proposed welding sequences which differentiate shop welds and field welds.

1.10.4 Shop Assembly Drawings

Shop assembly drawings shall provide details for connecting the adjoining fabricated components in the shop to ensure satisfactory field installation.

1.10.5 Hydraulic Schematic

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Hydraulic Schematic: Hydraulic schematics shall use symbols that are in accordance with ASME Y32.10. Information conveyed in the schematics shall be in accordance with ISO 1219. All hydraulic components shall be shown on the schematic, and all setpoint and size parameters shall be indicated for each component. Preliminary schematic shall be submitted for approval before fabrication of the equipment begins. Final schematic shall be submitted prior to the beginning of final equipment test. Changes occurring during installation of the equipment shall be reflect on As-built drawings. Contractor shall submit, for approval, As-built drawings at the time the government accepts the hydraulic power system.

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1.10.6 Delivery Drawings

Delivery drawings shall provide descriptions of methods of delivering components to the site, including details for supporting fabricated components during shipping to prevent distortion or other damage.

1.10.7 Field Installation Procedures

Field installation drawings shall provide a detailed description of the field installation procedures. The description shall include the location and method of support of installation and handling equipment, the provisions to be taken to protect concrete and other work during installation, the method of maintaining components in correct alignment, and the methods for installing other appurtenant items.

PART 2 PRODUCTS

2.1 HYDRAULIC POWER SYSTEM COMPONENTS

2.1.1 General

HYDRAULIC POWER SYSTEM COMPONENTS shall conform to the requirements indicated or specified, and if not specified, then HYDRAULIC POWER SYSTEM COMPONENTS of the best commercial grade quality suited to the intended use and as approved shall be furnished. The manufacturer's name, address, and catalog number shall be permanently displayed on a nameplate securely attached to each major item of equipment.

2.1.2 Standard Products

Where items are referred to hereinafter as "similar and equal to" a particular manufacturer's product, such references have been made merely as a convenient method of indicating the type of material or equipment required, with no intention of asserting superiority thereof. The standard product of any reputable manufacturer regularly engaged in the commercial production of the type and quality of material or equipment referred to will not be excluded on the basis of minor differences, provided essential requirements of the specifications relative to materials, capacity, and performance are met. The Contractor shall, in accordance with paragraph

SUBMITTALS, furnish for approval, performance capacities and other pertinent information concerning the manufacturer's "equal to" standard products which he intends to incorporate in the work. "Equal to" standard products installed or used without such approval shall be at the risk of subsequent rejection.

2.1.3 Hydraulic Cylinders
21
The hydraulic cylinder shall be of the single or double rod end type mill construction, as shown in the contract drawings, designed and manufactured to meet the criteria stated in paragraph DESIGN PARAMETERS. Stroke, bore and rod dimensions are shown on sheet M-23, M-26 and M-27 of the contract drawings. **Cylinder manufacturer shall be responsible for providing clevis and lifting eye ends of the cylinder. Miter gate and culvert valve cylinder shall be supplied with stop tubes. Stop tube length shall be sized to limit bearing pressure on the rod bearing and piston to 1000 psi maximum.**
*1***2**

2.1.3.1 Cylinder Tubes

Hydraulic cylinder tube shall have welded flanges and bolted heads and end caps as indicated in the contract drawings. The hydraulic cylinder tubes shall be a high strength carbon or alloy steel. Cylinder tubes which have been welded shall be stress relief heat treated and all welds shall be radiographed including those on mounts.

2.1.3.2 Cylinder Rods
***2**
Cylinder rods shall be provided with the type of rod ends indicated. The amount of adjustment indicated for clevis connections shall be fully provided with no reduction in strength. Miter gate latch cylinders shall be provided with cushions on both the rod and head sides of the piston.

1. Carbon or Alloy Steel Rods: Piston rods shall be a high strength carbon or alloy steel with a ceramic coating. Ceramic coating shall have a 0.008 inch minimum thickness, surface finish of 12 microinches RMS or better, surface hardness of 67 Rockwell C minimum, impact resistance of 5 to 11 lb-ft, modulus of elasticity of 52 x 10^6 to 60 x 10^6 psi, linear expansion coefficient of 4.0 x 10^{-6}/degree F, and be capable of withstanding a fracture force of 41 ksi minimum. The ceramic coating shall provide a homogeneous, uninterrupted, non-conducting and impermeable layer capable of providing corrosion resistance for a minimum of 1000 hours in accordance with ASTM G 85. The use of sealers shall not be permitted.
***2**

2. Stainless Steel Rods: Cylinder rod shall be plated with chrome. Chrome plating shall be 0.008" thick and shall be in accordance with ASTM B 177.

2.1.3.3 Position Indicators
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Electric components, of the position indicators external to the cylinders, shall be housed in an enclosure that meet the IP 68 standard in accordance with IEC 60529. Position indicator control wiring from the hydraulic

cylinder to control buildings shall be enclosed in conduits, junction boxes, etc., that meet the IP 68 standard.

1. Miter gate and culvert valve cylinders shall be supplied with position indicators and transmitters to meet the electrical characteristics given in section 16900 paragraphs titled "MITER GATE CONTROL" and "CULVERT VALVE CONTROL". The position indicator and transmitter shall be integral to the hydraulic cylinder. The position indicator and transmitter will connect to the control system described in section 16900 CONTROL AND INSTRUMENTATION. Position indicators shall be capable of determining cylinder position, at any position along the stroke, upon restoration of power after an electrical interruption/outage without resetting or recalibrating the indicator.
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2. Miter gate latch cylinders shall have two double pole single throw (DPST) normally open limit switches integral with the cylinder. One limit switch shall be fabricated in the rod cap, the other fabricated in the head end cap. The limit switch contacts shall be closed by an actuator that engages the cylinder cushions at the ends of the cylinders stroke. The limit switches will connect to the control system described in section 16900 CONTROL AND INSTRUMENTATION.

2.1.3.4 Miscellaneous Cylinder Components

Rings, bearings, packing, packing rings, retaining rings, seals, wiper-scrapers, etc., shall be manufacturers standard products fabricated from the finest selected quality materials. Piping connections shall be SAE J1926/1 or SAE J1453 fittings. Air bleed ports shall be provided. Valve manifolds shall conform to ANSI B93.7,

2.1.3.5 Mounts, Connections and Bearings

Mounts, brackets, clevis and pinned connections shall be of the style shown on the contract plans. Trunnions and connecting pins shall be fabricated from ASTM A 564/A 564M, Type 630, Condition H-1150, stainless steel and chrome plated in accordance with ASTM B 177. Surface finish on trunnions and connecting pins shall be the minimum required for the selected approved bearings/bushings installed. Trunnion and clevis bearings shall be self lubricating bearing such as HMI wearing and bearing "Feroform T814" or Thordon "HPSXL TRAXL" or an approved equal. Graphite or oil impregnated bearings will not be acceptable.
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2.1.4 Hydraulic Power Units

The hydraulic power units shall be a designed by the Contractor in accordance with ANSI T3.16.3 and as specified below to operate the hydraulic cylinders based on the criteria stated in the paragraph DESIGN PARAMETERS. The power units shall be designed to meet the space limitations shown on the contract drawings and shall be configured essentially as shown in the hydraulic schematic on sheet M-31. Hydraulic power unit shall consist of pumps, motors, oil reservoir, and valve manifolds with pressure relief valves and hydraulic fluid conditioners, pressure switches and gauges, temperature sensing and indicating devices, control console. Noise level shall not exceed 77dB at design fluid pressures and flow rates at distance of 7 feet. Electrical work shall conform to section 16415 ELECTRICAL WORK, INTERIOR.

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2.1.4.1 Fluid Reservoirs

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The fluid reservoir shall be 250 gallon capacity. The reservoir shall be made of stainless steel with welded joints and shall conform to the requirements of ANSI T3.16.2 R1 and as shown. Threaded fittings and ports, and flange connections shall be SAE type. The reservoir shall be equipped with a site glass for fluid indication and float switches for high fluid level (warning and shutoff), low level (warning and shutoff). Fluid reservoir shall be equipped with fluid heater, thermometer, and temperature indicator and transmitter. Reservoir shall also be equipped with valve and filter manifolds. There shall be a baffle provided between the intake and return lines to facilitate the separation of air and foreign matter from the hydraulic fluid. Both the intake and return pipes shall be brought down to a distance of 1 1/2 pipe diameters above the tank bottom. Interior surfaces of the reservoir shall be cleaned down to bright metal and coated with an epoxy-based urethane finish or an approved alternate that is compatible with oil and water.

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2.1.4.2 Reservoir Manifolds

Reservoir manifolds shall be in accordance with paragraph titled MANIFOLDS. One manifold shall have pump pressure relief valves mounted onto it. The other manifold shall provide a mounting point for the system filters.

2.1.4.3 Reservoir Heater

The reservoir shall be provided with one or more screw plug type immersion heaters with a watt density not to exceed 11 watts per square inch and a built-in thermostat set to maintain the hydraulic oil at 55 degrees F. The heater sheath and screwplug shall be fabricated from stainless steel. The surface of the heater element shall not exceed 10 watts per square inch at the design voltage. The heater shall be a 460 volt, 60 Hz, 3 phase type heater. The heater shall be supplied with stainless steel, NEMA 4X terminal housing as a minimum.

2.1.4.4 Flexible Breather

Each hydraulic power unit shall be provided with a flexible bladder breather to eliminate the introduction of outside air during normal operation of the hydraulic system. The breathers shall be sized by the contractor. Each bladder shall come complete with an internal desiccant dryer and a pressure/vacuum relief valve. The desiccant drier shall be readily accessible for maintenance and shall have an easily replaceable desiccant cartridge. The dryer shall have an indicator that changes color to indicate when the dryer requires changing. The breather bladders shall be compatible with the specified hydraulic fluid. The contractor shall provide all materials necessary to connect the breather. An emergency vent valve shall be provided in the breather piping to permit venting the reservoir during setup or extra ordinary operation. The air in the reservoir will be directed to the flexible breather during normal operations.

2.1.4.5 Pumps

Shall be a electric motor-driven, variable or fixed displacement as indicated on the contract plans. Pumps shall deliver fluid to meet requirements shown in the paragraph titled DESIGN PARAMETERS. The pumps shall have a minimum overall efficiency of 88% at the maximum flow rate given in the paragraph DESIGN PARAMETERS. Pumps shall be manufacturers standard catalog item for a minimum of two years and is currently commercially available. The pumps shall not exceed the power rating of the specified motor at all operating conditions. All the components of the pumps shall be compatible with the specified hydraulic fluid. Maximum rotating speed shall be 1800 rpm. Exposed rotating parts shall be properly safety guarded. The pumps shall mount on the reservoir in a manner similar to that shown on the drawings. The pumps shall be rated for continuous operation at a discharge pressure equal to or greater than the system design pressure. The rated discharge capacity of each pump shall not be less than indicated when the pump is operated at the design input speed and discharge pressure. Pumps 1 and 2 shall be axial piston, pressure-compensated variable displacement type with integral horsepower limiting, suitable for pumping hydraulic oil into a closed hydraulic system. Pump 3 shall be fixed displacement gear type. Each pump shall be independently operable such that failure of one pump will not disable the entire hydraulic power unit.

2.1.4.6 Pump Pressure Relief Valves

Pump pressure relief valves shall be manifold mounted and in accordance with paragraph PRESSURE RELIEF VALVES.

2.1.4.7 Motors

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The motors shall operate on 460 volts, 60 Hz, three phase power and have NEMA B design with Class F or H insulation. Motors shall conform to the applicable requirements of NEMA Pub. No. MG1. Motors shall have maximum speed of 1800 rpm. The motor shall be rated for continuous full load operation without exceeding the standard temperature rise for the class of insulation and frame construction used. The motor shall have a 1.15 service factor. Each pump shall be driven by an individual motor. Motors for pumps 1 and 2 shall be 40 HP. Motor for pump 3 shall be 7 1/2 HP. The motor shall be mounted in such a manner as to allow for start-up and operation of the motor and pump without transmitting excessive vibration or other forces to the hydraulic power unit in a detrimental manner. Motors shall be connected to pump drive shafts by flexible drive couplings that are adequately rated for the horsepower and torque being transmitted.

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2.1.4.8 Kidney Loop Filter Circuit

Kidney loop filters shall be manifold mounted. Filter circuit shall be equipped with bypass valves and pressure differential switches to monitor filter contamination. Filters shall be spin-on type. Contractor shall provide additional filtration if required for their selected and approved equipment. Filter capacity and efficiency shall be rated per ISO 4572.

Filter efficiency shall in terms of Beta ratio. Filter collapse strength shall be rated per ISO 2941. Filter collapse strength shall be greater than the differential pressure across filter element at 90 percent contamination capacity. Bubble point of the filter elements shall be rated per ISO 2942. The filter shall be rated for use with mineral oil based hydraulic fluid. Compatibility with hydraulic media shall be tested in accordance with ISO 2943. Filter media temperature range shall be 32°F to 160°F. Pressure differential switches shall be set to close when pressure drop across the filter elements is equal to 80 percent contamination condition of the filter.

a. Primary Filter - The filter element selected shall have a minimum rating of $Beta_2$ = 20, $Beta_3$ = 75 and $Beta_6$ = 200.

b. Water Removal Filter - Filter elements shall separate water from mineral oil based fluids. The filtration rating shall be 40 μm absolute, $Beta_{40}$ = 75. Maximum permissible differential pressure across filter elements is 145 psi.

2.1.4.9 Return Line Filter

Filter shall be manifold mounted. Filter circuit shall be equipped with bypass valve and pressure differential switch to monitor filter contamination. Filter shall be spin-on type. Contractor shall provide additional filtration if required for their selected and approved equipment. Filter capacity and efficiency shall be rated per ISO 4572. Filter efficiency shall be in terms of Beta ratio. Filter collapse strength shall be rated per ISO 2941. Filter collapse strength shall be greater than the differential pressure across filter element at 90 percent contamination capacity. Bubble point of the filter elements shall be rated per ISO 2942. The filter shall be rated for use with mineral oil based hydraulic fluid. Compatibility with hydraulic media shall be tested in accordance with ISO 2943. Filter media temperature range shall be 32°F to 160°F. Pressure differential switch shall be set to close when pressure drop across the filter element is equal to 80 percent contamination capacity of the filter. The filter element selected shall have a minimum rating of $Beta_5$ = 10, $Beta_{10}$ = 75 and $Beta_{15}$ = 200.
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2.1.4.10 Thermometer

A direct indicating thermometer shall be provided to indicate fluid temperature in the reservoir. The thermometer shall be of the bimetallic type mounted directly on the reservoir. The thermometer shall have a minimum 3 inch dial with black markings on a white background. The scale range shall be 20 to 240 degrees F. The case and stem shall be corrosion resistant, and the wetted components shall be stainless steel. Thermometer wells of the separable socket type shall be provided for each thermometer.

2.1.4.11 Temperature Transducer
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Temperature transducer and transmitter shall be provided to sense the oil temperature in the reservoir and function within the temperature range of 20 - 240 degrees Fahrenheit. The temperature transducer shall be of the thermocouple type. The temperature transmitter shall have a 4-20 mA

output signal. Temperature indicator and transmitter shall connect to the PLC control system, described in section 16900 CONTROL AND INSTRUMENTATION, so that the lock operator may monitor and be warned about hydraulic oil temperature conditions.
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2.1.4.12 Fluid Level Float Switches
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Float switches shall be single pole double throw. Float switches shall connect to the PLC control system and warn the lock operator of low/high fluid levels.
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2.1.4.13 Differential Pressure Switch

Pressure differential switch shall be connect to the PLC control system to alert the lock operator to possible contaminated filters. Pressure switches shall have a minimum pressure rating of 5000 psi. Pressure switches shall be set to close at the relief valve setting. Pressure switches shall be connected to the control system described in section 16900 CONTROL AND INSTRUMENTATION. The switches shall be provided with contacts having a minimum rating of 5 amps, 125/250 volts AC.
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2.1.4.14 Gauges

Pressure gauges shall be installed on the hydraulic power units as indicated. Each pressure gauge shall have a pressure snubber. Pressure gauges and pressure snubbers shall be as specified in paragraphs "PRESSURE GAUGES" and "PRESSURE SNUBBERS" respectively. *1
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2.1.4.15 Control Console

A control console shall be mounted on the hydraulic power unit. Console shall allow the starting/stopping of the hydraulic power unit; Shall be able to start/stop pumps individually; Shall have indicators showing which pumps are running; Shall show vital information using LED displays such fluid flow rates (gpm), fluid pressures (psi)and temperatures (degrees F). Electrical components contained in the control console shall be as specified in the paragraph "ELECTRICAL EQUIPMENT", below. Console will be a basic frame with metal panels using standardized components where available to meet the functional characteristics specified. The console shall be constructed of steel meeting the requirements of NEMA ICS 6. Steel sheet shall conform to ASTM A 659/A 659M. Removable panels shall be secured in place using captive, spring-loaded, self-locking spring nuts and hardened sheet metal screws. Screws and nuts shall be stainless steel. Access panels shall be secured with spring-loaded, quarter-turn fasteners with studs held captive in the removable panel. The console shall be equipped with adequate louvered panels to ventilate the interior and dissipate the heat generated within the console. Special equipment supports and guides shall be provided as required to support the equipment and other components within the console. The interior and exterior surfaces shall be finished with one coat of primer and two coats of the manufacturer's standard baked-on white enamel finish.
*1

2.1.4.16 Nameplates and Instruction Plates

Nameplates shall be provided for each device on the control console. Nameplates shall clearly indicate the function of each device. Instruction plates shall clearly indicate the proper procedures and sequences of operations to activate the system, to operate the system, and to secure the system after completion of operation. Lettering on nameplates shall be machine engraved on steel plate. Instruction plates shall be mounted on a rigid backing and covered with clear, rigid plastic sheeting. Instruction plates shall be mounted in a location easily visible to an operator stationed at the console or panel.

2.1.4.17 Security Provisions

Control consoles shall be constructed to prevent unauthorized or accidental operation of the system. The main power control switch mounted on the control console shall be a key-operated type. The control console shall be provided with a hinged cover with a key-operated lock arranged to automatically lock the cover in the closed position.
*1***3**
2.1.5 Pressure Gauges

Pressure gauges shall conform to ASME B40.100, have a black enameled metal case, a 4 inch dial, and a stainless steel Bourdon tube. **The scale range of the gauge shall be 0 psig to the maximum obtainable pressure in the line in which installed in psig**. Gauges shall be the safety type with solid fronts and blowout backs. Each gauge shall be provided with a pressure snubber. The pressure gauges shall be panel mounted or manifold mounted as shown. Gauges shall have a ball valve installed as shown so that pressure may be shut off to the gauge port for service. ***3***1

2.1.6 Pressure Transducer and Transmitter
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Pressure transducer and transmitter shall be provided to sense the oil pressure at the positions indicated on the hydraulic schematic in contract plans and function within the pressure range of 0 - 5000 psig. The transmitter shall produce a 4-20 mA output signal. The transmitter will connect to the PLC control system described in Section 16900 CONTROL AND INSTRUMENTATION. Pressure transducer and transmitter shall have a ball valve installed as shown so that pressure may be shut off to the port for service.
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2.1.7 Pressure Snubber

Pressure snubber shall be provided for all pressure gauges, pressure switches, and pressure transducers to protect against shock and provide more stable instrument operation. Snubber shall be of stainless steel construction.

2.1.8 Manifolds
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Valve and filter manifolds shall be provided for as indicated on sheet M-31 in the contract plans. Each manifold shall be constructed of aluminum or ductile iron by machining from a solid block of material. Material

selection shall be suitable for the design pressures and environment. Manifolds shall be fabricated by a manufacturer regularly engaged in the production of custom valve manifolds for at least 10 years. Manifolds shall be in accordance with ANSI B93.7. Ports and passages shall be machined smooth and shall be free of burrs and sharp corners. Manifold interconnecting passages and valving shall be so arranged as to provide the system connections and functions as shown on the drawings. Surfaces and recesses, where valving and other components will be installed, shall be machined to the manufacturers standard specifications of the applicable valve component. It shall be the responsibility of the Contractor to confirm the dimensions for all valve surfaces and recesses. Provision shall be made for attaching the hydraulic piping and tubing to the manifolds by the use of flanged or threaded connections. Flanged and threaded connection shall be of the SAE type. The manifolds shall be designed for an internal pressure of not less than 5000 psi. Components shall be located on the manifold in positions where they may be readily replaced or adjusted after installation.

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2.1.9 Valves

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Valves shall have a minimum pressure rating of 5000 psi unless stated otherwise. Valves shall have a operating temperature range of -20 to 160 degrees Fahrenheit. Valves shall be specifically designed and rated for hydraulic system applications. The flow rating shall be verified by the Contractor in accordance with the design criteria stated in paragraph DESIGN PARAMETERS. The valve**s** shall be a sized for 150% of the maximum anticipated flow rates. Valve seals shall be compatible for use with the specified hydraulic fluid. Valve seals and seats shall be replaceable without disturbing the piping if valve is line mounted. Valves shall be supplied with all hardware required for mounting. Threaded ports where used shall conform to SAE J1453.

*1

2.1.9.1 Ball Valves

Ball valves shall be made of stainless steel. Valves 1 inch or larger shall have socket-welded piping connections. Valves less than 1 inch shall have thread ends. Handles shall be stainless steel, or chrome plated carbon or alloy steel.

2.1.9.2 Control Valves

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a. Flow - Flow control valve shall be cartridge type for manifold mounting. The valves shall be pressure-compensating, and adjustable. Flow adjustment shall range from 0 gpm to 7.5 gpm. The valves shall be capable of being locked in position to prevent an unintentional adjustment.

b. Solenoid-Controlled Four-Way Directional Control Valves - Solenoid-controlled four-way directional control valves shall be three position and spring centered as shown. The valves shall have two solenoids. The valves shall be manifold mounted. The solenoids shall operate at 120 volts AC. The valves shall have manual overrides capability on the valve body.

c. Proportional Valves - Proportional valve assemblies shall be manifold mounted. The valve assemblies shall consist of a four-way, three-position, Proportional directional control valve with on-board electronics. The valve shall have built-in electronics to accept discrete or variable inputs for actuator speed control as stated in the DESIGN PARAMETERS. The electronics shall be capable of calibration in order that actuator speed may be fine tuned. The valve shall have manual override capability on the valve body. Each valve shall be furnished with a suitable regulated power supply with overvoltage protection.

d. Solenoid Operated Flow Diverter - Solenoid-controlled three-way flow diverter valves shall be two position as shown. Valves shall be spring positioned as shown. The valves shall have one solenoid that operates on 120 volts AC. The valves shall be manifold mounted. The valves shall have manual override capability on the valve body.

*1

2.1.9.3 Pressure Relief Valves

Pressure relief valves shall be adjustable.

*1

a. Internally Piloted - A full flow relief valve shall be used where shown. The valves shall have an adjustment range of 50 to 3500 psi. Adjustable orifices shall be provided as necessary for proper functioning and smooth operation of the valve. The valve shall be pilot operated, cartridge design for manifold mounting.

b. Externally Piloted - A full flow relief valve shall be used to provide system pressure relief and venting. The valve shall have a minimum adjustment range of 1000 to 5000 psi. The valves shall be pilot operated by an external source, and be manifold mounted.

*1

2.1.9.4 Check Valves

Check valves shall be of cartridge type for manifold mounting designed for high shock and 5000 psi service unless otherwise noted below. Check valves shall have zero leakage when seated.

a. Filter Bypass Spring Loaded Check Valves - Shall be designed for 3500 psi service. Cracking pressure shall be selected based on the differential pressure characteristics of the chosen filter elements.

*1

2.1.9.5 Counterbalance Valves

Counterbalance valves shall be installed as indicated to balance the load being held by the cylinders. Valves shall be of the type shown on sheet M-31 and specified below. The valves shall be directly operated and shall be adjustable for operating over a expected pressure range. The valves shall be designed for a system operating pressure of 3000 psi, with pressures peaking as high as 5000 psi.

a. Flow Controlled Counterbalance Valves - Valves shall be of the load check type. The valves shall be leak-free, pilot operated, with tamper proof pressure setting for opening. When closed, the valves shall prevent cylinder drift. The valves shall be externally piloted. The pilot ratio shall be 20:1. When the valve is in the open position the flow of fluid through the valve shall be throttled to prevent the actuator from "running away". The flow rate of fluid through the valve shall be restricted when flow rate out of the actuator exceeds pump flow rate into the actuator. Valves shall be manifold mounted where they may be readily replaced and adjusted after installation. Valves shall be similar and equal to Rexroth Model No. FD..PA2X/B.., See data sheet RA 27 5.51/5.94.

b. Counterbalance Valve With Manual Bypass - Valves shall be of the load check type. The valve shall be leak-free, pilot operated for opening. When closed, the valve shall prevent cylinder drift. The valve shall be externally piloted. The pilot ratio shall be 3:1. Cracking pressure shall be 50 psi. When the valve is in the open position the flow of fluid through the valve shall be unrestricted. Valves shall be manifold mounted in positions where they may be readily replaced or adjusted after installation.

c. Manually Operated Counterbalance Valves - Valves shall be of the load check type. The valves shall be leak-free. When closed, the valve shall prevent cylinder drift. Valves shall open only by manual operator located on the valve body. When the valve is open flow of fluid through the valve shall be unrestricted. Valves shall be manifold mounted in positions where they may be readily replaced or adjusted after installation.

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2.1.9.6 Air Bleed Valves

Bleeder valves shall be 1/4 inch, stainless steel construction, and wrench operated.

2.1.10 Power Piping

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Hydraulic piping shall be **socket** welded stainless steel pipe in accordance with ASME B31.1 and Section 05093 WELDING PRESSURE PIPING excluding flexible hoses and hydraulic tubing. Flexible hoses shall be used at hydraulic cylinders as shown. Threaded fittings shall be used to make flexible hose connections. Stainless steel tubing and fittings may be used on the hydraulic cylinders.

*1***2**

2.1.10.1 Stainless Steel Pipe

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Pipe shall be seamless stainless steel conforming to ASME B36.19M and ASTM A 312/A 312M, Grade TP304. The piping weight class shall be as shown. Stainless steel piping shall have the internal diameter cleaned of grease, mill scale, burrs and foreign objects then the ends capped by the supplier.

*1

2.1.10.2 Pipe Fittings

*1

Pipe fittings shall be the socket welding type conforming to ASME B16.11 and made of stainless steel conforming to and ASTM A 182/A 182M, Grade F304. The pressure class shall be 6,000 pounds per square inch. Unions shall be the O-ring type, made of stainless steel with socket-welding ends. The

Contractor may at his option substitute four bolt split flanges with Buna N or Viton O-rings for the unions. Flanges shall conform to ASTM A 182/A 182M with the grade suitable for the pipe to which attached. Flange shall conform to SAE J518. Threaded fittings shall also conform to the above, but shall be used only where absolutely necessary for the application. Threaded fittings where used shall conform to SAE J1453.
*1

2.1.10.3 Hydraulic Tubing

Tubing shall be seamless stainless steel tubing conforming to ASTM A 789/A 789M. The wall thickness shall be selected to provide a safety factor of 6 based on the manufacturer's ratings for burst strength.

2.1.10.4 Tube Fittings
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Tube fittings shall be made of stainless steel and be the flareless type with SAE straight threads and Buna N or Viton O-ring seals. The threads on fittings shall conform with SAE J1453. *1
*1

2.1.10.5 Flexible Hydraulic Hose

Flexible hydraulic lines shall be wire-reinforced, high-pressure-type hose made of neoprene or Buna N. Hose shall be resistant to sunlight. Flexible hose shall be rated by the manufacturer for a working pressure not lower than the system operating pressure with a factor of safety of 4. Fittings shall be specifically designed for use with the hose selected and shall be as recommended by the hose manufacturer. Fittings shall be made of stainless steel and shall be the reusable type. Hose fittings shall be SAE J1453.
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2.1.11 Bolts, Nuts, and Washers

2.1.11.1 Structural Bolted Connections

Structural bolted connections carrying primary loads shall be made with ASTM A 325 bolts with ASTM A 563 nuts and ASTM F 436 hardened washers.

2.1.11.2 Stainless Steel Bolts, Nuts and Washers

Stainless steel bolts and nuts shall conform to ASTM A 193/A 193M, Grade B7 or B16, with ASTM A 194/A 194M, Grade 8 nuts. Flat washers shall conform to ASTM F 844.
*1
2.1.12 Hydraulic Fluid

The selected and approved hydraulic fluid shall be available to the project from a distributor located in or around the Louisville, KY area. The hydraulic fluid shall be an ashless, mineral oil based product with the following properties. The hydraulic fluid chosen shall be approved for use with all components of the system. The fluid shall have a viscosity grade of ISO VG 46 and viscosity index of 140 minimum. Water separation shall occur in less than 10 minutes in accordance with ASTM D 1401 to prevent emulsions and promote removal. The fluid shall have additives that inhibit rust and oxidation and provide anti-wear and anti-foam properties. Oxidation life shall be 3000 hours or greater in accordance with ASTM D 943. It shall pass rust protection test in accordance with ASTM D 665 A & B. Foaming Tendency/Stability as determined by ASTM D 892 sequence I, II, and III and shall be 20/0. The fluid shall have a maximum pour point of -49 degrees F as determined by ASTM D 97. Minimum flash point of 331 degrees F as measured by ASTM D 92. Viscosity shall meet 225 SUS at 100 degrees F and 53 SUS at 210 degrees F. The selected hydraulic fluid shall be used during shop testing, to fill the cylinders before shipment, flush the syst em piping, and to fill the complete hydraulic system. Only fresh hydraulic fluid shall be added to the installed system and individual components during testing . Hydraulic fluid added to the installed system shall be transferred from storage drums to the reservoir using a Portable Filtering System as specified herein. All hydraulic fluid shall be supplied by the Contractor and two 55 gallon containers shall be furnished to the Government for a reserve supply.

2.1.13 Portable Filtering System

The contractor shall provide a portable filtering system consisting of a cart with drip tray, pump and motor, two hose assemblies, and two filter assemblies. The cart and drip tray shall be of welded steel construction and painted with a coating that is resistant to hydraulic fluids. Cart shall have wheels with steel axles and two handles with hand grips. Pump shall be gear type and have 10 gpm capacity at 3450 rpm. Motor shall be 115 volt, single phase, 60 Hz, rated 0.75 hp at 3450 rpm. Motor shall have thermal overload protection. Motor shall come with 20 foot electrical cord with retractable cord reel. Hose assemblies shall each consist of 6 foot of flexible PVC hose and 3 foot wand of rigid PVC pipe. Transition from flexible hose to pipe shall be made with metal fittings and metal hose clamps. One hose assembly shall connect to the inlet filter, the other hose assembly shall connect to the outlet filter. System shall have one intake filter assembly and one outlet filter assembly. Filter assembly shall consist of an aluminum filter bowl and head, filter and steel tubing. Head shall contain filter bypass valve and visual indicator of filter cleanliness. Head shall bolt to the filter bowl. Visual indicator shall be differential pressure type and have 3 band scale (clean, change, bypass). Head shall be serviceable. Flexible hose end of the hose assembly shall connect to the head. Tubing shall be steel and connect the filter bowl to the gear pump using threaded fluid connectors. Filter installed in the intake filter assembly shall be of the water removal type. At 10 gpm the intake filter shall have the water capacities for fluids with the following viscosities,

Capacity	Fluid Viscosity
190 mL	75 SUS
80 mL	200 SUS

Outlet filter shall have the following beta ratios B_2=2, B_6=20 and B_9=75. Outlet filter media shall be cellulose or microglass. All seals shall be BUNA N.

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2.2 ELECTRICAL EQUIPMENT

2.2.1 General
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Electrical equipment not otherwise specified elsewhere in this specification section shall be as follows. Other electrical materials and equipment required for the installation of the hydraulic power systems not covered in this specification section and above elevation 443 shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR. Electrical items installed below elevation 443 shall be rated IP 68 against water intrusion as defined in IEC 60529. All electrical equipment furnished shall be standard catalog items under regular manufacture with existing catalog ratings equal to or better than the requirements of the contract drawings and specifications. The Contractor's request for approval of equipment other than as specified or as shown shall be accompanied by technical and descriptive data and specifications sufficient for the Contracting Officer to determine its adequacy. Unless otherwise specified or indicated, all electrical materials and equipment shall meet the standards, specifications, and tests referenced.
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2.2.2 Conduit, Duct, and Accessories

Threads on the following equipment shall be American Standard. No metric threads will be accepted.

2.2.2.1 Conduit and Cabinet Supports

Conduit and cabinets shall be supported as required by ANSI 70. The supports shall be galvanized.

2.2.3 Cabinets and Boxes

Cabinets and boxes shall be stainless steel, NEMA 4X housings sized as required. The cabinet and box hubs shall be consistent with the NEMA 4X rating of the box. Cabinets and boxes shall be mounted such that the NEMA 4X rating is not compromised. Threads on the hubs shall match the threads on the conduit and shall be American Standard. Metric threads will not be accepted. The cabinets and boxes shall conform to UL 50.

2.2.4 Control Components

2.2.4.1 Control Devices and Wiring
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Manual or automatic control, protective or signal devices required for the specified operation and all control wiring for these controls and devices shall be provided whether indicated or not. Electrical control devices shall have minimum current and voltage ratings in accordance with the requirements of NEMA ICS 2 contact rating designation A 300, as applicable, unless larger ratings are indicated or are required. Control devices shall be provided with the number and arrangement of contacts required to perform the specified control functions. Devices located indoors shall be provided with or installed in NEMA 4X enclosures. Devices located outdoors below elevation 443 shall be installed in enclosures or pathways rated as IP68.
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2.2.4.2 Electronic Limit Switches
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The electronic limit switches shall have solid-state, thumbwheel, programmable limits with a count/revolution range of 0000 to 3599; four decades of limit programming; set point switch function selection; initial power supply that provides four AC power levels (plus 5 V, plus 15 V, plus 24 V, **plus 120 V**) from standard 120 or 240 VAC sources; and outputs for read-outs on two digital displays (one remote digital read-out in the control room and one at the hydraulic power unit). The operating temperature range of the electronic limit switches shall be minus 20 degrees C to plus 65 degrees C. The limit switches shall be located and mounted as shown.

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2.2.4.3 Manual Switches

Manually operated switches, including push-button switches, selector switches, and key-operated switches, shall be heavy-duty, oil-tight type conforming to the requirements of NEMA ICS 1.

2.2.4.4 Relays

Relays used in control circuits shall be industrial magnetic control relays conforming to NEMA ICS 2 contact rating designation A 300, except where other ratings are indicated. Relays shall be applied in control circuits in such a manner that proper control functions shall be obtained regardless of whether the contacts are overlapping or non-overlapping.

2.2.4.5 Indicating Lights

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Indicating light assemblies shall be the switchboard type, insulated for 120 volt AC service, with appropriate colored caps as indicated and integrally mounted resistors for 120 volt AC service. Color caps shall be made of a material which will not be softened by the heat from the lamp. Lamps shall be replaceable from the front of the panel, and any special tools required for lamp replacement shall be furnished by the Contractor. The indicating light assemblies shall be the same product line as compatible push buttons and switches.

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2.3 SPARE PARTS

The Contractor shall furnish spare parts in the quantities listed below:

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ITEM	QUANTITY
1. Miter Gate Hydraulic Cylinder	1
2. Culvert Valve Hydraulic Cylinder	1
3. Variable Volume, Pressure Compensated, Horsepower Limiting Hydraulic Axial Piston Pump, (HPU Pump 1 & 2)	1
4. 40 Horsepower Motor for (HPU Pump 1 & 2)	1
5. Fixed Displacement Gear Pump (HPU Pump 3)	1
6. 7.5 Horsepower Motor for (HPU Pump 3)	1
7. Hydraulic Fluid Filters	3 of each type
8. Miter Gate Latch Hydraulic Cylinder	1
9. Proportional Directional Control Valve	1

ITEM	QUANTITY
for Culvert Valve Hydraulic Cylinder	
10. Proportional Directional Control Valve for Miter Gate Hydraulic Cylinder	1
11. Directional Control Valve for Miter Gate Latch Cylinder	1
12. Flow Controlled Counterbalance Valve for Culvert Valve Cylinder	1
13. Flow Controlled Counterbalance Valve for Miter Gate Cylinder	1 of each type
14. Manually Operated Counterbalance Valve for Culvert Valve Cylinder	1
15. Manually Operated Counterbalance Valve for Miter Gate Cylinder	1
16. Counterbalance Valve with Manual Bypass for Miter Gate Latch Cylinder	1
17. Pressure Relief Valve for HPU Pumps 1 & 2	1
18. Pressure Relief Valve for HPU Pump 3	1
19. Externally Piloted Pressure Relief Valve for Miter Gate Cylinder	1 of each type
20. 3 inch and 1.5 inch Ball Valves	2 of each type
21. Hydraulic Position Indicators	2 of each type

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PART 3 EXECUTION

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3.1 SHOP ASSEMBLY AND TESTING

Each hydraulic power system shall be completely shop assembled and tested insofar as is possible using temporary piping and wiring to determine the correctness of fabrication and the matching of component parts to ensure acceptable operation after field erection. Shop tests shall be made in the presence of a representative of the Contracting Officer. Hydraulic power equipment shall not be shipped to the project site until shop assembly and testing has been, in the opinion of the representative of the Contracting Officer, satisfactorily completed. in the completion of the shop assembly and testing, preliminary acceptance will be made by the Contracting Officer.

3.1.1 Cleaning

Extreme care shall be taken during shop assembly to avoid inclusion of foreign materials into the equipment. Interior surfaces of hydraulic cylinders, fluid reservoirs, valve manifolds and temporary piping shall be free of visible contamination. Temporary piping and/or hoses connecting hydraulic power system components shall be flushed with the selected hydraulic fluid at a fluid velocity to create fully turbulent flow (Reynolds Number in excess of 4000). Fluid used for flushing shall be discarded. Hydraulic fluid used during shop assembly and testing shall have a cleanliness level of at least 14/11 in accordance with ISO 4406 and water content below 200 ppm. Prior to filling hydraulic equipment and flushing of piping, the equipment manufacturer shall take three 500 milliliter samples of hydraulic fluid from each storage container at different depths according to NFPA B93.19M to verify cleanliness level and water content. Testing of cleanliness level and water content shall be verified by an independent testing lab. Particle counting on each sample shall be performed in accordance with SAE ARP 598B

3.1.2 Cylinder Tests

Each cylinder shall be filled with the specified hydraulic fluid using the above specified PORTABLE FILTERING SYSTEM, taking care to exclude all air. **Each cylinder shall then be hydrostatically tested at 3000 psi on the rod end for a minimum of 4 hours.** With the rod end fluid port blocked and a pressure gauge attached, pressurize the head end of the cylinder until the rod end test pressure is reached. Measure the position of the cylinder rod and record. Observe the pressure gauge. If pressure loss occurs at any time during the test, observe hydraulic cylinder for visible leakage, or advancing cylinder rod. Any cylinder displaying visible leakage will be rejected. If no visible leakage is found observe cylinder rod. Remeasure the position of the cylinder rod. A change in position of the cylinder rod indicates internal leakage in the cylinder. The hydraulic cylinder shall be rejected if the internal leakage is greater than 0.5 cc per minute for the miter gate and culvert valve cylinders and 0.05 cc per minute for the miter gate latch cylinders . The specified acceptable internal leakage equates to a change in position of the cylinder rod as follows

Cylinder Type	Allowable Cylinder Rod Change of Position
Miter Gate Cylinder	0.063 inch
Culvert Valve Cylinder	0.146 inch
Miter Gate Latch Cylinder	0.311 inch

3.1.3 Hydraulic Power Unit Testing

Each hydraulic power unit shall be filled with the specified hydraulic fluid using the above specified PORTABLE FILTERING SYSTEM. Once the hydraulic power unit is filled the hydraulic fluid shall be circulated by operating the kidney loop filter circuit a minimum of 4 hours, changing filters as they become contaminated. At the end of 4 hours, the fluid cleanliness level shall be checked to verify it meets at least 14/11 in accordance with ISO 4406 and water content below 200 ppm. Hydraulic fluid shall continue to be circulated until the fluid meets the required cleanliness level. Shop-fabricated hydraulic power units and control valves and valve manifolds shall be hydrostatically tested at the maximum pressure allowed by the installed equipment. Valves and operators shall undergo a functional test and the pumps shall be tested to verify flow and pressure ratings. The power unit shall then be connected to a hydraulic cylinder and operationally tested at 3,000 psi. Any operational problems will be cause for rejection.

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3.2 INSTALLATION

3.2.1 General

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The Contractor shall install the equipment specified and as shown on the drawings to complete the hydraulic power system for operation of the miter gate leaves, culvert valves, and miter gate latches. Installation of hydraulic components shall be in accordance with the manufacturer's written instructions and under the direction of the erection engineer or manufacturer's representative. Hydraulic power units, and hydraulic cylinders shall be installed without disassembly. Necessary supports for all appurtenances, pumps, motors, and other equipment or components shall be provided. Floor-mounted equipment shall be anchored to the floor by anchor bolts or expansion anchors. Installation shall be in accordance with Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS and Section 16415 ELECTRICAL WORK, INTERIOR.

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3.2.2 Cleaning and Flushing the System

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Extreme care shall be taken during assembly to avoid the entrance of abrasives, dirt, metal chips, and other foreign materials into the hydraulic system through open ends of piping, tubing, and ports of the components. Power piping and valve manifolds shall be flushed with warm hydraulic fluid (150 degrees F) at fluid velocities great enough to create fully turbulent flow, (Reynolds Number in excess of 4000), in all piping. Temporary filters shall be installed in the piping during flushing procedure. Hydraulic power unit pumps shall not be used for flushing procedure. The Contractor shall submit a detailed cleaning and flushing procedure for approval in accordance with paragraph SUBMITTALS. The procedure shall include a detailed description of the equipment, materials, solution temperatures, duration of each phase of the cleaning operation, and method of drying after cleaning. The procedure shall clean the system of particles so that the contamination level is below 14/11 in accordance with ISO 4406. The Contractor shall take three 500 milliliter samples at approved locations according to NFPA B93.19M. Particle counting on each sample shall be performed in accordance with SAE ARP 598B by an approved independent test laboratory. Water content of each sample shall be below 200 ppm. If any sample does not comply with the permissible contamination limits, the system shall be recleaned and reinspected. When flushing is completed, the system shall be drained and then filled with the specified hydraulic fluid.

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3.2.3 Filling and Bleeding the System

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Hydraulic fluid used to fill the system shall be filtered through a the portable filtering system specified above. Once the hydraulic power unit reservoirs are filled the hydraulic fluid shall be circulated by operating the kidney loop filter circuit a minimum of 4 hours, changing filters as they become contaminated. At the end of 4 hours the fluid cleanliness level shall be checked to verify it meets at least 14/11 in accordance with ISO 4406 and water content below 200 ppm. Hydraulic fluid shall continue to be circulated until the fluid meets the required cleanliness level. The complete hydraulic power system shall be bled to remove all air from the system. Care shall be taken to exclude as much air as possible during initial filling. The hydraulic cylinders shall be filled in the horizontal position with the piping connections up to allow air to escape, and the piping shall be filled in a manner that excludes as much air as possible. The system, once filled, shall be bled of air, operated, and periodically bled during the first week of operation to remove any air that might have been entrained in the system.

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3.3 PAINTING

All exposed exterior surfaces of assemblies and equipment except stainless steel, synthetic rubber, and plastic, shall be shop primed and coated as specified in Section 09965 PAINTING: HYDRAULIC STRUCTURES unless the equipment is given a standard factory finish as allowed by other paragraphs of this specification. Insofar as is practicable, the complete coating system shall be applied to individual components and items before assembly to ensure complete coverage and maximum protection against corrosion. Equipment such as the pumps which have a factory-finished coating do not need to be recoated. Chips, scratches, and other damage to shop-applied painted surfaces shall be repainted in the field.

3.4 FIELD TESTS AND INSPECTIONS

3.4.1 Field Testing

The Contracting Officer shall be given 2 weeks notice before any field testing is to be conducted. Any material, equipment, instruments, and personnel required for the tests shall be provided by the Contractor. Testing shall be conducted in the presence of the Contracting Officer unless waived in writing and then a certified field test report shall be submitted in accordance with paragraph SUBMITTALS. Testing shall be done under the direction of the erection engineer or manufacturer's representative.

3.4.2 Proof Testing

The piping system shall be hydrostatically tested to not less than 125 percent of the design working pressure. Any equipment that might be damaged by this pressure shall be isolated or removed to prevent damage. The proof test pressure shall be maintained for 12 hours. All welded, flanged, and threaded connections shall be carefully examined for leakage, and all lines shall be inspected for evidence of deflection caused by inadequate anchorage. No leakage or deflection will be allowed.

3.4.3 Final Acceptance Tests

In preparation for the final acceptance tests, and after completion of the installation and proof tests, the Contractor shall operate the hydraulic power system to prove acceptability. Preliminary tests shall be conducted at minimum pressures and velocities until initial adjustments have been proven safe for normal operation. Details of all operations shall be constantly monitored for signs of impending trouble and corrections shall be made as necessary to prevent damage to the equipment. At such time as the Contracting Officer may direct, the Contractor shall conduct the following complete acceptance tests on the hydraulic power system for approval. Any deficiency or maladjustment disclosed by the tests shall be corrected immediately and the test repeated until satisfactory results are obtained. No subsequent tests will be permitted until all preceding tests have been completed satisfactorily. Upon completion of the final acceptance tests, the Contractor shall furnish a written statement that the hydraulic power system has been field tested and meets all operational requirements.

3.4.3.1 Initial Start-Up

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The hydraulic reservoir shall be inspected to ensure that the fluid is at the proper level. The hydraulic pumps shall be test started using both the controls at the control console and the remote controls. The pumps shall be inspected for proper operation and discharge pressure. Pressure compensator and horsepower limiting features of the hydraulic pumps shall be set and verified. The discharge pressure of each pump shall be read and recorded. **The pressure relief valves shall be adjusted to limit the system pressure to the specified value. The hydraulic lines and components which are under pressure shall be inspected for evidence of leakage.**

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3.4.3.2 Combined System Tests

Tests and inspections of the hydraulic power system shall be performed concurrently with the testing specified under other sections of these specifications which test the mechanism operated by the hydraulic system. The hydraulic system shall be tested by operating the mechanism through a minimum of four complete cycles. During each test operation, the hydraulic lines and components shall be inspected for evidence of leakage. The pressure in the supply and return lines for each direction of operation shall be read and recorded. Response of components to operation of applicable controls shall be inspected to ensure that all connections have been made properly. Flow control valves shall be checked and adjusted as required to conform to indicated operating time requirements.

3.4.3.3 Test Reports

The Contractor shall prepare and complete test reports showing in detail the results of the field tests. The test reports shall include a detailed tabulation showing values of pressures, flow rates, and all adjustments recorded during the final tests, and adjustment and calibration of the entire system. During each test run, the following data and observations shall be recorded:

a. Control operation

b. Voltages

c. Currents

d. Pressures

e. Speeds and times

f. Flow control valve settings

g. Alignment and operating clearances

h. Excessive vibration, by component

i. Temperature of motors and hydraulic fluid

j. Pertinent observations regarding such events as unusual sounds, malfunctions or difficulties encountered, and adjustments required.

3.5 ERECTION ENGINEER

The Contractor shall obtain the services of an experienced erection engineer who is regularly employed by the hydraulic cylinder/power unit manufacturer to supervise the installation, start-up, adjustment and operation, and testing of the equipment provided. The erection engineer shall furnish a signed statement stating that the final installation and start-up of the hydraulic power system has been inspected, witnessed, and complies fully with the manufacturer's warranty requirements. The erection engineer shall also instruct the Government's operating staff members in the operation and maintenance features of the equipment.

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15070

SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT

04/99

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SECTION 15070

SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT
04/99

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ENGINEERING TECHNICAL INSTRUCTIONS AND ENERGY SAVINGS ANALYSIS

TI 809-04	(1998) Seismic Design for Buildings

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Seismic Restraint Mnl	(1998) Seismic Restraint Manual Guidelines for Mechanical Systems

1.2 PAYMENT

No separate payment shall be made items and work contained in this specification. Payment shall be incidental to bid item CONTROL BUILDINGS, HYDRAULIC POWER SYSTEMS, RAW WATER SYSTEM, COMPRESSED AIR SYSTEM

1.3 SYSTEM DESCRIPTION

1.3.1 General Requirements

The requirements for seismic protection measures described in this section shall be applied to the mechanical equipment and systems listed below. Structural requirements shall be in accordance with Section 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

1.3.2 Mechanical Equipment

Mechanical equipment to be seismically protected shall include the following items to the extent required in other sections of these specifications:

***3**

Piping	**Valves and Fittings for Piping**
Air Handling Units	**Heat Pumps**
Unit Heaters	**Intake and Exhaust Fans**
Fuel Oil Tanks	**Ducts**
Water Heater	**Air Compressors**

Air Compressor **Compressed Air Receivers**
Compressed Air Dryers **Hydraulic Power Units**
Pumps with Motors **Hydraulic Control Valve Manifolds**
***3**

1.3.3 Mechanical Systems

The following mechanical systems shall be installed as required on the drawings and other sections of these specifications and shall be seismically protected in accordance with this specification:
***3**

All Water Supply Systems
Sewage System
Hydraulic Power Systems
HVAC Systems (Equipment and Ducts)
Compressed Air Systems
Electrical Generator
Fuel Storage Tanks
Raw Water Systems

***3**

1.3.4 Contractor Designed Bracing

The Contractor shall design the bracing in accordance with TI 809-04 and additional data furnished by the Contracting Officer. Resistance to lateral forces induced by earthquakes shall be accomplished without consideration of friction resulting from gravity loads. TI 809-04 uses parameters for the building, not for the equipment in the building; therefore, corresponding adjustments to the formulas shall be required. Loadings determined using TI 809-04 are based on strength design; therefore, the AISC LRFD Specifications shall be used for the design. The bracing for the following mechanical equipment and systems shall be developed by the Contractor: All.

1.3.5 Items Not Covered By This Section1.3.5.1 Items Requiring No Seismic Restraints

Seismic restraints are not required for the following items:
***3**

a. NOT USED

***3**

b. Piping equipment rooms less than 1 inch inside diameter.

c. All other piping less than 2-1/2inches inside diameter.

d. Rectangular air handling ducts less than 6 square feet in cross sectional area.

e. Round air handling ducts less than 28 inches in diameter.

f. Piping suspended by individual hangers 12 inches or less in length from the top of pipe to the bottom of the supporting structural member where the hanger is attached, except as noted below.

g. Ducts suspended by hangers 12inches or less in length from the top of the duct to the bottom of the supporting structural member, except as noted below.

In exemptions f. and g. all hangers shall meet the length requirements. If the length requirement is exceeded by one hanger in the run, the entire run shall be braced. Interior piping and ducts not listed above shall be seismically protected in accordance with the provisions of this specification.

1.4 EQUIPMENT REQUIREMENTS

1.4.1 Rigidly Mounted Equipment

The following specific items of equipment to be furnished under this contract shall be constructed and assembled to withstand the seismic forces specified in TI 809-04, Chapter 10. Each item of rigid equipment shall be entirely located and rigidly attached on one side only of a building expansion joint. Piping, duct, electrical conduit, etc., which cross the expansion joint shall be provided with flexible joints that are capable of accommodating displacements equal to the full width of the joint in both orthogonal directions.

***3**

Electrical Generator
Remote Cooling Radiator for Electrical Generator
Hydraulic Power Units
Hydraulic Cylinders
Air Compressors
Compressed Air Receivers
Compressed Air Dryers
Hydraulic Controls Valve Manifolds
Fuel Oil Storage Tank
Fuel Oil Day Tank

***3**

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Data

Coupling and Bracing; GA, ED. Equipment Requirements; GA, ED.

Copies of the design calculations with the detail drawings. Calculations shall be stamped by a registered engineer and shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

Contractor Designed Bracing; GA, ED.

Copies of the design calculations with the drawings. Calculations shall be approved, certified, stamped and signed by a registered Professional Engineer. Calculations shall verify the capability of structural members to which bracing is attached for carrying the load from the brace.

SD-04 Drawings

Coupling and Bracing; FIO. Flexible Couplings or Joints; FIO. Equipment Requirements; FIO. Contractor Designed Bracing; GA, ED.

Detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the items listed. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

SD-13 Certificates

Flexible Ball Joints; FIO.

Flexible ball joints shall be certified to be suitable for the service intended by the manufacturer. Information verifying experience at not less than 3 locations of 2 years' satisfactory operation in a similar application shall be submitted.

PART 2 PRODUCTS

2.1 FLEXIBLE COUPLINGS

Flexible couplings shall have same pressure and temperature ratings as adjoining pipe.

2.2 FLEXIBLE BALL JOINTS

Flexible ball joints shall have cast or wrought steel casing and ball parts capable of 360-degree rotation with not less than 15-degree angular movement.

2.3 FLEXIBLE MECHANICAL JOINTS

a. Mechanical couplings for pipe shall be of the sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movement caused by expansion, contraction, slight settling or shifting of the ground, minor variations in trench gradients, and traffic vibrations. Where permitted in other sections of these specifications, joints utilizing split-half couplings with grooved or shouldered pipe ends may be used.

b. Sleeve-type couplings shall be used for joining plain-end pipe sections. The coupling shall consist of one steel middle ring, two steel followers, two gaskets, and necessary steel bolts and nuts to compress the gaskets.

2.4 MANUFACTURED BALL JOINTS

Manufactured ball joints shall be as recommended by the manufacturer for the intended use and shall be approved by the Contracting Officer before installation.

2.5 SWAY BRACING MATERIALS

Sway bracing materials (e.g. rods, plates, rope, angles, etc.) shall be as specified in Section 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT.

PART 3 EXECUTION

3.1 COUPLING AND BRACING

Coupling installation shall conform to the details shown on the drawings. Provisions of this paragraph apply to all piping within a 5 foot line around outside of building unless buried in the ground. Piping grouped for support on trapeze-type hangers shall be braced at the same intervals as determined by the smallest diameter pipe of the group. Bracing rigidly attached to pipe flanges, or similar, shall not be used where it would interfere with thermal expansion of piping.

3.2 DRIFT

Joints capable of accommodating seismic displacements shall be provided for vertical piping between floors of the buildings, where pipes pass through a seismic or expansion joint, or where rigidly supported pipes connect to equipment with vibration isolators. Horizontal piping across expansion joints shall accommodate the resultant of the drifts of each building unit in each orthogonal direction. For threaded piping, swing joints made of the same piping material shall be provided. For piping with manufactured ball joints the seismic drift shall be 0.015 feet per foot of height above the base where the seismic separation occurs; this drift value shall be used in place of the expansion given in the manufacturer's selection table.

3.3 FLEXIBLE COUPLINGS OR JOINTS

3.3.1 Building Piping

Flexible couplings or joints in building piping shall be provided at bottom of all pipe risers for pipe larger than 3-1/2 inches in diameter. Flexible couplings or joints shall be braced laterally without interfering with the action of the flexible coupling or joint.

3.3.2 Underground (including utility trenches)Piping

Buried piping and 4 inch or larger conduit shall have flexible couplings installed where the piping crosses monolith expansion joints and piping enters utility trenches and lock gallerys from esplanade crossing. The couplings shall accommodate 2 inches of relative movement between the pipe and the building in any direction. Additional flexible couplings shall be provided where shown on the drawings.

3.4 PIPE SLEEVES

Pipe sleeves in interior non-fire rated walls shall be sized as indicated on the drawings to provide clearances that will permit differential movement of piping without the piping striking the pipe sleeve. Pipe sleeves in fire rated walls shall conform to the requirements in Section 07840 FIRESTOPPING.

3.5 SPREADERS

Spreaders shall be provided between adjacent piping runs to prevent contact during seismic activity whenever pipe or insulated pipe surfaces are less than 4 inches apart. Spreaders shall be applied at same interval as sway braces at an equal distance between the sway braces. If rack type hangers are used where the pipes are restrained from contact by mounting to the rack, spreaders are not required for pipes mounted in the rack. Spreaders shall be applied to surface of bare pipe and over insulation on insulated pipes utilizing high-density inserts and pipe protection shields in accordance with the requirements of Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.6 SWAY BRACES FOR PIPING

Sway braces shall be provided to prevent movement of the pipes under seismic loading. Braces shall be provided in both the longitudinal and transverse directions, relative to the axis of the pipe. The bracing shall not interfere with thermal expansion requirements for the pipes as described in other sections of these specifications.

3.6.1 Transverse Sway Bracing

Transverse sway bracing for steel and copper pipe shall be provided as specified in Section 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT. All runs (length of pipe between end joints) shall have a minimum of two transverse braces. Transverse sway bracing for pipes of materials other than steel and copper shall be provided at intervals not to exceed the hanger spacing as specified in Section 15400 PLUMBING, GENERAL PURPOSE.

3.6.2 Longitudinal Sway Bracing

Longitudinal sway bracing shall be provided at 40 foot intervals unless otherwise indicated. All runs (length of pipe between end joints) shall have one longitudinal brace minimum. Sway braces shall be constructed in accordance with the drawings. Branch lines, walls, or floors shall not be used as sway braces.

3.6.3 Vertical Runs

Run is defined as length of pipe between end joints. Vertical runs of piping shall be braced at not more than 10 foot vertical intervals. Braces for vertical runs shall be above the center of gravity of the segment being braced. All sway braces shall be constructed in accordance with the drawings. Sway branches shall not be connected to branch lines, walls, or floors.

3.6.4 Clamps and Hangers

Clamps or hangers on uninsulated pipes shall be applied directly to pipe. Insulated piping shall have clamps or hangers applied over insulation in accordance with Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.7 SWAY BRACES FOR DUCTS

3.7.1 Braced Ducts

Bracing details and spacing for rectangular and round ducts shall be in accordance with SMACNA Seismic Restraint Mnl, including Appendix E. However, the design seismic loadings for these items shall not be less than loadings obtained using the procedures in TI 809-04.

3.7.2 Unbraced Ducts

Hangers for unbraced ducts shall be attached to the duct within 2 inches of the top of the duct in accordance with SMACNA Seismic Restraint Mnl. Unbraced ducts shall be installed with a 6 inch minimum clearance to vertical ceiling hanger wires.

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15080

THERMAL INSULATION FOR MECHANICAL SYSTEMS

11/99

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SECTION 15080

THERMAL INSULATION FOR MECHANICAL SYSTEMS
11/99

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 580/A 580M	(1998) Stainless Steel Wire
ASTM B 209	(1996) Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C 195	(1995) Mineral Fiber Thermal Insulating Cement
ASTM C 449/C 449M	(1995) Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C 518	(1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 533	(1995) Calcium Silicate Block and Pipe Thermal Insulation
ASTM C 534	(1999) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 547	(1995) Mineral Fiber Pipe Insulation
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 553	(1992) Mineral Fiber Blanket Thermal

	Insulation for Commercial and Industrial Applications
ASTM C 610	(1995) Molded Expanded Perlite Block and Pipe thermal Insulation
ASTM C 612	(1993) Mineral Fiber Block and Board Thermal Insulation
ASTM C 647	(1995) Properties and Tests of Mastics and Coating Finishes for Thermal Insulation
ASTM C 665	(1998) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C 795	(1998el) Thermal Insulation for Use in Contact With Austenitic Stainless Steel
ASTM C 916	(1985; R 1996e1) Adhesives for Duct Thermal Insulation
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 921	(1989; R 1996) Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM C 1126	(1998) Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM C 1136	(1995) Flexible, Low Permeance Vapor retarders for Thermal Insulation
ASTM C 1290	(1995) Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HV AC Ducts
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Water Vapor Transmission of Materials

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds	(1993) National Commercial & Industrial Insulation Standards

1.2 SYSTEM DESCRIPTION

Field-applied insulation and accessories on mechanical systems shall be as specified herein; factory-applied insulation is specified under the piping, duct or equipment to be insulated. Field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS shall be furnished and installed by the Contractor.

1.3 GENERAL QUALITY CONTROL

1.3.1 Standard Products

Materials shall be the standard products of manufacturers regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.3.2 Installer's Qualifications

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

1.3.3 Surface Burning Characteristics

Unless otherwise specified, insulation not covered with a jacket shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Insulation systems which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Insulation materials located exterior to the building perimeter are not required to be fire-rated. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets , facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

1.3.4 Identification of Materials

Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-14 Samples

Thermal Insulation Materials; GA, ED.

A complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories for each mechanical system requiring insulation shall be included. Materials furnished under this section of the specification shall be submitted at one time.

After approval of materials and prior to applying insulation a booklet shall be prepared and submitted for approval. The booklet shall contain marked-up MICA Insulation Stds plates (or detail drawings showing the insulation material and insulating system) for each pipe, duct, or piece of equipment required to be insulated per this specification. The MICA plates shall be marked up showing the materials to be installed in accordance with the requirements of this specification for the specific insulation application. The Contractor shall submit all MICA Plates required to show the entire insulating system, including Plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. If the Contractor elects to submit detailed drawings instead of marked-up MICA Plates, the detail drawings shall show cut-away, section views, and details indicating each component of the insulation system and showing provisions for insulating jacketing, and sealing portions of the equipment. For each type of insulation installation on the drawings, provide a label which identifies each component in the installation (i.e., the duct, insulation, adhesive, vapor retarder, jacketing, tape, mechanical fasteners, etc.) Indicate insulation by type and manufacturer. Three copies of the booklet shall be submitted at the jobsite to the Contracting Officer. One copy of the approved booklet shall remain with the insulation Contractor's display sample and two copies shall be provided for Government use.

After approval of materials actual sections of installed systems properly insulated in accordance with the specification requirements shall be displayed. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. Display sample sections will be inspected at the jobsite by the Contracting Officer. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

Pipe Insulation Display Sections: Display sample sections shall include as a minimum an elbow or tee, a valve, dielectric unions and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

Duct Insulation Display Sections: Display sample sections for rigid and flexible duct insulation used on the job. A display section for duct insulation exposed to weather shall be protected by enclosing with a temporary covering.

1.5 PAYMENT

No separate payment shall be made items and work contained in this specification. Payment shall be incidental to bid item CONTROL BUILDINGS

1.6 STORAGE

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. Insulation material and supplies that become dirty, dusty, wet, or otherwise contaminated may be rejected by the Contracting Officer.

PART 2 PRODUCTS

2.1 GENERAL MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:

2.1.1 Adhesives

2.1.1.1 Acoustical Lining Insulation Adhesive

Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C 916, Type I.

2.1.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C 195.

2.1.1.3 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. Lagging adhesives shall be nonflammable and fire-resistant and shall have a flame spread rating no higher than 25 and a smoke developed rating no higher than 50 when tested in accordance with ASTM E 84. Adhesive shall be pigmented [white] [red] and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bounding fibrous glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations.

2.1.2 Contact Adhesive

Adhesive may be dispersed in a nonhalogenated organic solvent or, dispersed in a nonflammable organic solvent which shall not have a fire point below 200 degrees F. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The adhesive shall be nonflammable and fire resistant.

2.1.3 Caulking

ASTM C 920, Type S, Grade NS, Class 25, Use A.

2.1.4 Corner Angles

Nominal 0.016 inch aluminum 1 x 1 inch with factory applied kraft backing. Aluminum shall be ASTM B 209, Alloy 3003, 3105, or 5005.

2.1.5 Finishing Cement

Mineral fiber hydraulic-setting thermal insulating cement ASTM C 449/C 449M. All cements that may come in contact with Austenitic stainless steel must include testing per ASTM C 795.

2.1.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth and glass tape shall have flame spread and smoke developed ratings of no greater than 25/50 when measured in accordance with ASTM E 84. Tape shall be 4 inch wide rolls.

2.1.7 Staples

Outward clinching type ASTM A 167, Type 304 or 316 stainless steel.

2.1.8 Jackets

ASTM C 921, Type I, maximum moisture vapor transmission 0.02 perms, (measured before factory application or installation), minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is acceptable. Minimum tensile strength, 35 pound/inch width. ASTM C 921, Type II, minimum puncture resistance 25 Beach units, tensile strength minimum 20 pound/inch width. Jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing. Based on the application, insulation materials which require factory applied jackets are mineral fiber, cellular glass, and phenolic foam. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84.

2.1.8.1 White Vapor Retarder All Service Jacket (ASJ)

For use on hot/cold pipes, ducts, or equipment vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

2.1.8.2 Aluminum Jackets

Aluminum jackets shall be corrugated, embossed or smooth sheet, 0.016 inch nominal thickness; ASTM B 209, Temper H14, Temper H16, Alloy 3003, 5005, or 3105 with factory applied moisture retarder. Corrugated aluminum jacket shall not be used outdoors. Aluminum jacket securing bands shall be Type 304 stainless steel, 0.015 inch thick, 1/2 inch wide for pipe under 12 inch diameter and 3/4 inch wide for pipe over 12 inch and larger diameter. Aluminum jacket circumferential seam bands shall be 2 x 0.016 inch aluminum matching jacket material. Bands for insulation below ground shall be 3/4 x 0.020 inch) thick stainless steel, or fiberglass reinforced tape. The jacket may, at the option of the Contractor, be provided with a factory fabricated Pittsburgh or "Z" type longitudinal joint. When the "Z" joint is used, the bands at the circumferential joints shall be designed by the manufacturer to seal the joints and hold the jacket in place.

2.1.8.3 Polyvinyl Chloride (PVC) Jackets

Polyvinyl chloride (PVC) jacket and fitting covers shall have high impact strength, UV resistant rating or treatment and moderate chemical resistance with minimum thickness 0.030 inch.

2.1.9 Vapor Retarder Coating

The vapor retarder coating shall be fire and water resistant and appropriately selected for either outdoor or indoor service. Color shall be white. The water vapor permeance of the compound shall be determined according to procedure B of ASTM E 96 utilizing apparatus described in ASTM E 96. The coating shall be a nonflammable, fire resistant type. All other application and service properties shall be in accordance with ASTM C 647.

2.1.9.1 Vapor Retarder Required

ASTM C 1136, Type I, maximum moisture vapor transmission 0.02 perms, minimum puncture resistance 50 Beach units on all surfaces except concealed ductwork, where Type II, maximum moisture vapor transmission 0.02 perms, a minimum puncture resistance of 25 Beach units is acceptable.

2.1.9.2 Vapor Retarder Not Required

ASTM C 1136, Type III, maximum moisture vapor transmission 0.10 perms, minimum puncture resistance 50 Beach units on all surfaces except ductwork, where Type IV, maximum moisture vapor transmission 0.10, a minimum puncture resistance of 25 Beach units is acceptable.

2.1.10 Wire

Soft annealed ASTM A 580/A 580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2 PIPE INSULATION MATERIALS

Pipe insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.2.1 Aboveground Cold Pipeline

Insulation for minus 30 degrees to plus 60 degrees F for outdoor, indoor, exposed or concealed applications,, shall be as follows:

a. Cellular Glass: ASTM C 552, Type II, and Type III. Supply the insulation with manufacturers recommended factory applied jacket.

b. Flexible Cellular Insulation:ASTM C 534, Type I or II. Type II shall have vapor retarder skin on both sides of the insulation.

c. Phenolic Insulation: ASTM C 1126, Type III. Phenolic insulations shall comply with ASTM C 795 and with the ASTM C 665 paragraph Corrosiveness. Supply the insulation with manufacturers recommended factor applied jacket.

d. Mineral Fiber: ASTM C 547

2.2.2 Aboveground Hot Pipeline

Insulation for above 60 degrees F, for outdoor, indoor, exposed or concealed applications shall meet the following requirements. Supply the insulation with manufacturers recommended factory applied jacket.

a. Mineral Fiber: ASTM C 547, Types I, II or III, supply the insulation with manufacturers recommended factory applied jacket.

b. Calcium Silicate: ASTM C 533, Type I indoor only, or outdoors above 250 degrees F pipe temperature.

c. Cellular Glass: ASTM C 552, Type II and Type III. Supply the insulation with manufacturers recommended factory applied jacket.

d. Flexible Cellular Insulation: ASTM C 534, Type I or II to 200 degrees F service.

e. Phenolic Insulation: ASTM C 1126 Type III to 250 F service shall comply with ASTM C 795. Supply the insulation with manufacturers recommended factory applied jacket.

f. Perlite Insulation: ASTM C 610

2.3 DUCT INSULATION MATERIALS

Duct insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.3.1 Rigid Mineral Fiber

ASTM C 612, Type IA, IB, II, III, & IV.

2.3.2 Flexible Mineral Fiber

ASTM C 553, Type I,or Type II up to 250 F. ASTM C 1290 Type III.

2.3.3 Cellular Glass

ASTM C 552, Type I.

2.3.4 Phenolic Foam

ASTM C 1126 Type II, shall comply with ASTM C 795.

2.3.5 Flexible Cellular

ASTM C 534 Type II.

2.4 EQUIPMENT INSULATION MATERIALS

Equipment insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.4.1 Cold Equipment Insulation

For temperatures below 60 degrees F.

2.4.1.1 Cellular Glass

ASTM C 552, Type I, Type III, or Type IV as required.

2.4.1.2 Flexible Cellular Insulation

ASTM C 534, Type II.

2.4.1.3 Phenolic Foam

ASTM C 1126 Type II shall comply with ASTM C 795.

2.4.2 Hot Equipment Insulation

For temperatures above 60 degrees F.

2.4.2.1 Rigid Mineral Fiber

ASTM C 612, Type IA, IB, II, III, IV, or V as required for temperature encountered to 1800 degrees F.

2.4.2.2 Flexible Mineral Fiber

ASTM C 553, Type I, II, III, IV, V, VI or VII as required for temperature encountered to 1200 degrees F.

2.4.2.3 Calcium Silicate

ASTM C 533, Type I, indoors only, or outdoors above 250 degrees F. Pipe shape may be used on diesel engine exhaust piping and mufflers to 1200 degrees F.

2.4.2.4 Cellular Glass

ASTM C 552, Type I, Type III, or Type IV as required.

2.4.2.5 Flexible Cellular Insulation

ASTM C 534, Type II, to 200 degrees F.

2.4.2.6 Phenolic Foam

ASTM C 1126 Type II to 250 degrees F shall comply with ASTM C 795.

2.4.2.7 Molded Expanded Perlite

ASTM C 610.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds standard plates except where modified herein or on the drawings.

3.1.2 Firestopping

Where pipes and ducts pass through fire walls, fire partitions, above grade floors, and fire rated chase walls, the penetration shall be sealed with fire stopping materials as specified in Section 07840 FIRESTOPPING.

3.1.3 Installation of Flexible Cellular Insulation

Flexible cellular insulation shall be installed with seams and joints sealed with a contact adhesive. Flexible cellular insulation shall not be used on surfaces greater than 200 degrees F. Seams shall be staggered when applying multiple layers of insulation. Insulation exposed to weather and not shown to have jacketing shall be protected with two coats of UV resistant finish as recommended by the manufacturer after the adhesive is dry.

3.1.4 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. .

3.1.5 Pipes/Ducts/Equipment which Require Insulation

Insulation is required on all pipes, ducts, or equipment, except for omitted items, as specified.

3.2 PIPE INSULATION INSTALLATION

3.2.1 Pipe Insulation

3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

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a. NOT USED.

b. Chromium plated pipe to plumbing fixtures.

c. Sanitary drain lines.

d. Hydraulic fluid lines

e. Fuel oil lines

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3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

a. Pipe insulation shall be continuous through the sleeve.

b. An aluminum jacket with factory applied moisture retarder shall be provided over the insulation wherever penetrations require sealing.

c. Where penetrating interior walls, the aluminum jacket shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.

d. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.

e. Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 2 inchesabove the flashing with a band 1 inch from the end of the aluminum jacket.

f. For hot water pipes supplying lavatories or other similar heated service which requires insulation, the insulation shall be terminated on the backside of the finished wall. The insulation termination shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch applied with glass tape embedded between coats (if applicable). The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. Glass tape seams shall overlap 1 inch. Caulk the annular space between the pipe and wall penetration with approved fire stop material. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration at least 3/8 inch.

g. For domestic cold water pipes supplying lavatories or other similar cooling service which requires insulation, the insulation shall be terminated on the finished side of the wall (i.e., insulation must cover the pipe throughout the wall penetration). The insulation shall be protected with two coats of vapor barrier coating with a minimum total thickness of 1/16 inch. The coating shall extend out onto the insulation 2 inches and shall seal the end of the insulation. Caulk the annular space between the outer surface of the pipe insulation and the wall penetration with an approved fire stop material having vapor retarder properties. Cover the pipe and wall penetration with a properly sized (well fitting) escutcheon plate. The escutcheon plate shall overlap the wall penetration by at least 3/8 inch.

3.2.1.3 Pipes Passing Through Hangers

a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed.

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b. Horizontal pipes larger than 2 inches at 60 degrees F and above shall be supported on hangers in accordance with MSS SP-69, and **Section 15400 PLUMBING AND PIPING.**

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c. Horizontal pipes larger than 2 inches and below 60 degrees F shall be supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-69. An insulation insert of cellular glass or calcium silicate **or perlite (above 80 Fshall be installed above each shield**. The insert shall cover not less than the bottom 180 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the weight of the pipe from crushing the insulation, as an option to installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. ***3**

d. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360 degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe which are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.

e. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible cellular insulation shall conform to ASTM C 1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Cellular Pipe Insulation

Flexible cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less.Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

3.2.1.5 Pipes in high abuse areas.
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In equipment rooms, stainless steel or aluminum jackets shall be utilized. Pipe insulation to the 6 foot level shall be protected.
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3.2.2 Aboveground Cold Pipelines

Cold pipelines, minus 30 degrees to plus 60 degrees F, not previously excluded shall be insulated per Table I

3.2.2.1 Insulation Thickness

Insulation thickness for cold pipelines shall be determined using Table I.

Table I - Cold Piping Insulation Thickness
Pipe Size (inches)

Type of Service	Material	Runouts up to 2 in*	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
Refrigerant suction piping	CG		1.5	1.5	n/a	n/a	n/a
	FC		1.0	1.0	n/a	n/a	n/a
	PF		1.0	1.0	n/a	n/a	1.0
Raw water piping	CG	1.5	1.5	1.5	n/a	n/a	n/a
	FC	3/8	3/8	3/8	n/a	n/a	n/a
	PF	1.0	1.0	1.0	n/a	n/a	n/a
Cold domestic water	CG	1.5	1.5	1.5	n/a	n/a	n/a
	FC	3/8	3/8	3/8	n/a	n/a	n/a
	PF	1.0	1.0	1.0	n/a	n/a	n/a

LEGEND:

PF - Phenolic Foam
CG - Cellular Glass
MF - Mineral Fiber
FC - Flexible Cellular

***3**

3.2.2.2 Jacket for Mineral Fiber, Cellular Glass, and Phenolic Foam Insulated Pipe

Insulation shall be covered with a factory applied vapor retarder jacket or field applied seal welded PVC jacket. Insulation inside the building shown to be protected with an aluminum jacket shall have the insulation and vapor retarder jacket installed as specified herein. The aluminum jacket shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required. In high abuse areas such as janitor closets and traffic areas in equipment rooms, kitchens, and mechanical rooms, aluminum jackets shall be utilized. Pipe insulation to the 6 ft level will be protected.

3.2.2.3 Insulation for Straight Runs (Mineral Fiber, Cellular Glass and Phenolic Foam)

a. Insulation shall be applied to the pipe with joints tightly butted. All butted joints and ends shall be sealed with a vapor retarder coating.

b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches. Butt strips 3 inches wide shall be provided for circumferential joints.

c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. If staples are used, they shall be sealed per paragraph 3.2.2.3 e.

d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F during installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.

e. All Staples, including those used to repair factory self-seal lap systems, shall be coated with a vapor retarder coating. All seams, except those on factory self-seal systems shall be coated with vapor retarder coating.

f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating with vapor retarder coating. The patch shall extend not less than 1-1/2 inches past the break.

g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with vapor retarder coating.

3.2.2.4 Insulation for Fittings and Accessories

a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories. The butted joints and ends shall be coated with vapor retarder coating.

b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates except as modified herein: 5 for anchors; 10, 11, and 13 for fittings; 14 for valves; and 17 for flanges and unions. Insulation shall be the same insulation as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow'.

c. Upon completion of insulation installation on flanges, unions, valves, anchors, fittings and accessories, terminations, seams, joints and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of vapor retarder coating with a minimum total thickness of 1/16 inch, applied with glass tape embedded between coats. Tape seams shall overlap 1 inch.The coating shall extend out onto the adjoining pipe insulation 2 inches. Fabricated insulation with a factory vapor retarder jacket shall be protected with two coats of vapor retarder coating with a minimum thickness of 1/16 inch and with a 2 inch wide glass tape embedded between coats. Where fitting insulation butts to pipe insulation, the joints shall be sealed with a vapor retarder coating and a 4 inch wide ASJ tape which matches the jacket of the pipe insulation.

d. Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.

e. Insulation shall be marked showing the location of unions, strainers, and check valves.

3.2.2.5 Optional PVC Fitting Covers

At the option of the Contractor, premolded, one or two piece PVC fitting covers may be used in lieu of the vapor retarder and embedded glass tape. Factory precut or premolded insulation segments shall be used under the fitting covers for elbows. Insulation segments shall be the same insulation as the pipe insulation including same density, thickness, and thermal conductivity. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers. Seams in the cover, and tacks and laps to adjoining pipe insulation jacket, shall be sealed with vapor retarder tape to ensure that the assembly has a continuous vapor seal.

3.2.3 Aboveground Hot Pipelines

Hot pipelines above 60 degrees F, not previously excluded shall be insulated per Table II:

3.2.3.1 Insulation Thickness

Insulation thickness for hot pipelines shall be determined using Table II.

Table II - Hot Piping Insulation Thickness
Pipe Size (inches)

Type of Service (degrees F)	Material	Runouts up to 2 in *	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
Hot domestic water supply	CG		1.5	1.5	1.5	1.5	1.5
	FC		0.5	1.0	1.0	1.5	1.5
	PF		0.5	1.0	1.0	1.0	1.0
	MF		0.5	1.5	1.5	1.5	1.5
Electrical generator Coolant	CG		1.5	2.0	2.0	2.0	3.5
	PF		1.0	1.0	1.0	1.0	1.5
	MF		1.5	1.5	2.0	2.0	2.5
	CS/PL		1.5	2.0	2.5	2.5	3.5
Compressed Air discharge steam & condensate return (201-250 F)	CG		1.5	2.0	2.0	2.0	3.5
	PF		1.0	1.0	1.0	1.0	1.5
	MF		1.5	1.5	2.0	2.0	2.5
	CS/PL		1.5	2.0	2.5	2.5	3.5

LEGEND:
PF - Phenolic Foam
CG - Cellular Glass
CS - Calcium Silicate
MF - Mineral Fiber
FC - Flexible Cellular
PL - Perlite

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3.2.3.2 Jacket for Insulated Hot Pipe, Except Pipe Insulated with Flexible Cellular
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Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied **ASTM C 921** Type II jacket or field applied aluminum where required or seal welded PVC.

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3.2.3.3 Insulation for Straight Runs

a. Insulation shall be applied to the pipe with joints tightly butted.

b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches, and butt strips 3 inches wide shall be provided for circumferential joints.

c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. Adhesive may be omitted where pipe is concealed.

d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F and shall be installed in accordance with manufacturer's instructions. Laps and butt strips shall be stapled whenever there is nonadhesion of the system. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.

e. Breaks and punctures in the jacket material shall be patched by either wrapping a strip of jacket material around the pipe and securing with adhesive and staple on 4 inch centers (if not factory self-sealing), or patching with tape and sealing with a brush coat of vapor retarder coating. Adhesive may be omitted where pipe is concealed. Patch shall extend not less than 1-1/2 inches past the break.

f. Flexible cellular pipe insulation shall be installed by slitting tubular sections and applying onto piping or tubing. Alternately, whenever possible, slide unslit sections over the open ends of piping or tubing. All seams and butt joints shall be secured and sealed with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Insulation shall be pushed on the pipe, never pulled. Stretching of insulation may result in open seams and joints. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives shall be used. Type II sheet insulation when used on pipe larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

3.2.3.4 Insulation for Fittings and Accessories

a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories.

b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates, except as modified herein: 5 for anchors; 10, 11, 12,and 13 for fittings; 14, 15 and 16 for valves; 17 for flanges and unions; and 18 for couplings. Insulation shall be the same as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required. Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".

c. Upon completion of installation of insulation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of adhesive applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. Adhesive shall extend onto the adjoining insulation not less than 2 inches. The total dry film thickness shall be not less than 1/16 inch.

d. Insulation terminations shall be tapered to unions at a 45-degree angle.

e. At the option of the Contractor, factory premolded one- or two-piece PVC fitting covers may be used in lieu of the adhesive and embedded glass tape. Factory premolded segments or factory or field cut blanket insert insulation segments shall be used under the cover and shall be the same thickness as adjoining pipe insulation. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers.

3.2.4 Piping Exposed to Weather

Piping exposed to weather shall not be insulated.

3.2.5 Below ground Pipe Insulation

Below ground piping, including piping within lock wall trenches, shall not be insulated.

3.3 DUCT INSULATION INSTALLATION

Corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. Duct insulation shall be omitted on exposed supply and return ducts in air conditioned spaces unless otherwise shown. Air conditioned spaces shall be defined as those spaces directly supplied with cooled conditioned air.

3.3.1 Duct Insulation Thickness

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Duct insulation thickness shall be in accordance with Table III.

Table III - Minimum Duct Insulation (inches)

Cold Air Ducts, Including Generator Intake	**2.0**
Relief Ducts	**1.5**
Fresh Air Intake Ducts	**1.5**
Warm Air Ducts, Including Generator Exhaust	**2.0**
Relief Ducts	**1.5**
Fresh Air Intake Ducts	**1.5**

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Maximum thickness for flexible cellular insulation shall not exceed 1 inch to comply with ASTM E 84 flame spread/smoke developed ratings of 25/50.

3.3.2 Insulation and Vapor Retarder for Cold Air Duct

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Insulation and vapor retarder shall be provided cold air ducts **below 60 deg F**.

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf and rigid type where exposed, minimum density 3 pcf. Insulation for round/oval ducts shall be flexible type, minimum density 3/4 pcf with a factory Type I or II jacket; or, a semi rigid board, minimum density , 3 pcf, formed or fabricated to a tight fit, edges beveled and joints tightly butted and staggered, with a factory applied Type I or II all service jacket. Insulation for exposed ducts shall be provided with either a white, paintable, factory-applied Type I jacket or a vapor retarder jacket coating finish as specified. Insulation on concealed duct shall be provided with a factory-applied Type I or II vapor retarder jacket. The total dry film thickness shall be approximately . 1/16 inch. Duct insulation shall be continuous through sleeves and prepared openings except fire wall penetrations. Duct insulation terminating at fire dampers, shall be continuous over the damper collar and retaining angle of fire dampers, which are exposed to unconditioned air and which may be prone to condensate formation. Duct insulation and vapor retarder shall cover the collar, neck, and any uninsulated surfaces of diffusers, registers and grills. Vapor retarder materials shall be applied to form a complete unbroken vapor seal over the insulation. **Sheet Metal Duct shall be sealed in accordance with 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.**

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3.3.2.1 Installation on Concealed Duct

a. For rectangular, oval or round ducts, insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts, 24 inches and larger insulation shall be additionally secured to bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 16 inch centers and not more than 16 inches from duct corners.

d. Insulation shall be impaled on the mechanical fasteners (self stick pins) where used and shall be pressed thoroughly into the adhesive. Care shall be taken to ensure vapor retarder jacket joints overlap 2 inches. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type duct hangers.

e. Self-locking washers shall be installed where mechanical fasteners are used. The pin shall be trimmed back and bent over.

f. Jacket overlaps shall be secured with staples and tape as necessary to ensure a secure seal. Staples, tape and seams shall be coated with a brush coat of vapor retarder coating.

g. Breaks in the jacket material shall be covered with patches of the same material as the vapor retarder jacket. The patches shall extend not less than 2 inches beyond the break or penetration in all directions and shall be secured with tape and staples. Staples and tape joints shall be sealed with a brush coat of vapor retarder coating.

h. At jacket penetrations such as hangers, thermometers, and damper operating rods, voids in the insulation shall be filled and the penetration sealed with a brush coat of vapor retarder coating.

i. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish or tape with a brush coat of vapor retarder coating.. The coating shall overlap the adjoining insulation and uninsulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

j. Where insulation standoff brackets occur, insulation shall be extended under the bracket and the jacket terminated at the bracket.

3.3.2.2 Installation on Exposed Duct Work

a. For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches.

b. Duct insulation shall be formed with minimum jacket seams. Each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over.

c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and the pin trimmed or bent over.

d. Joints in the insulation jacket shall be sealed with a 4 inchwide strip of tape. Tape seams shall be sealed with a brush coat of vapor retarder coating.

e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with tape and stapled.

Staples and joints shall be sealed with a brush coat of vapor retarder coating.

f. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a brush coat of vapor retarder coating.

g. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The coating shall overlap the adjoining insulation and uninsulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

h. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation with minimum density of 3/4 pcf, attached as per MICA standards.

3.3.3 Insulation for Warm Air Duct

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Insulation and vapor barrier shall be provided warm, above 75 deg F air ducts and associated equipment.

Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf; and rigid type where exposed, minimum density 3 pcf. Insulation on exposed ducts shall be provided with a white, paintable, factory-applied Type II jacket, or finished with adhesive finish. Flexible type insulation shall be used for round ducts, minimum density 3/4 pcf with a factory-applied Type II jacket. Insulation on concealed duct shall be provided with a factory-applied Type II jacket. Adhesive finish where indicated to be used shall be accomplished by applying two coats of adhesive with a layer of glass cloth embedded between the coats. The total dry film thickness shall be approximately 1/16 inch. Duct insulation shall be continuous through sleeves and prepared openings. Duct insulation shall terminate at fire dampers and flexible connections.

***3**

3.3.3.1 Installation on Concealed Duct

a. For rectangular, oval and round ducts, insulation shall be attached by applying adhesive around the entire perimeter of the duct in 6 inch wide strips on 12 inch centers.

b. For rectangular and oval ducts 24 inches and larger, insulation shall be secured to the bottom of ducts by the use of mechanical fasteners. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corner.

c. For rectangular, oval and round ducts, mechanical fasteners shall be provided on sides of duct risers for all duct sizes. Fasteners shall be spaced on 18 inch centers and not more than 18 inches from duct corners.

d. The insulation shall be impaled on the mechanical fasteners where used. The insulation shall not be compressed to a thickness less than that specified. Insulation shall be carried over standing seams and trapeze-type hangers.

e. Self-locking washers shall be installed where mechanical fasteners are used and the pin trimmed and bent over.

f. Insulation jacket shall overlap not less than 2 inches at joints and the lap shall be secured and stapled on 4 inch centers.

3.3.3.2 Installation on Exposed Duct

a. For rectangular ducts, the rigid insulation shall be secured to the duct by the use of mechanical fasteners on all four sides of the duct, spaced not more than 16 inches apart and not more than 6 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger and a minimum of one row for each side of duct less than 12 inches.

b. Duct insulation with factory-applied jacket shall be formed with minimum jacket seams, and each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projection is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over the projection. Jacket shall be continuous across seams, reinforcing, and projections. Where the height of projections is greater than the insulation thickness, insulation and jacket shall be carried over the projection.

c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and pin excess clipped and bent over.

d. Joints on jacketed insulation shall be sealed with a 4 inch wide strip of tape and brushed with vapor retarder coating.

e. Breaks and penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with adhesive and stapled.

f. Insulation terminations and pin punctures shall be sealed with tape and brushed with vapor retarder coating.

g. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation, minimum density of 3/4 pcf attached by staples spaced not more than 16 inches and not more than 6 inches from the degrees of joints. Joints shall be sealed in accordance with paragraph 3.3.3.2 d.

3.3.4 Duct Test Holes

After duct systems have been tested, adjusted, and balanced, breaks in the insulation and jacket shall be repaired in accordance with the applicable section of this specification for the type of duct insulation to be repaired.

3.3.5 Duct Exposed to Weather

Duct exposed to weather shall not be insulated.

3.4 EQUIPMENT INSULATION INSTALLATION

3.4.1 General

Removable insulation sections shall be provided to cover parts of equipment which must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

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a. Handholes.

c. Cleanouts.

d. ASME stamps.

e. Manufacturer's nameplates.

***3**

3.4.2 Insulation for Cold Equipment

***3**

Insulation shall be furnished on equipment handling media below 60 degrees F, excluding .

a. Hydraulic Power Units.

b. Electrical Generator.

c. Fuel Oil Storage Tanks.

d. Submersible Pumps

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3.4.2.1 Insulation Type

Insulation shall be suitable for the temperature encountered. Thicknesses shall be as follows:

a. Equipment handling media between 35 and 60 degrees F: 1.5 inch thick cellular glass, 1 inch thick flexible cellular, or 1 inch thick phenolic foam.

b. Equipment handling media between 0 degree F and 34 degrees F: 3 inch thick cellular glass, 1 1/2 inch flexible cellular, or 1 1/12 inch thick phenolic foam.

c. Equipment handling media between minus 30 degrees F and 1 degree F: 3 1/2 inch thick cellular glass 1 3/4 inch thick flexible cellular, or 1 1/2 inch thick phenolic foam.

3.4.2.2 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12 inch centers except flexible cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. Cellular glass and phenolic foam insulation shall be set in a coating of bedding compound, and joints shall be sealed with bedding compound as recommended by the manufacturer.

d. Insulation on heads of heat exchangers shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint. The entire surface of the removable section shall be finished by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch.

e. Exposed insulation corners shall be protected with corner angles.

f. Insulation on equipment with ribs shall be applied over 6 x 6 inches by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 x 2 incheswashers or shall be securely banded or wired in place on 12 inch centers.

3.4.2.3 Vapor Retarder

Upon completion of installation of insulation, penetrations shall be caulked. Two coats of vapor retarder coating shall be applied over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

3.4.3 Insulation for Hot Equipment
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Insulation shall be furnished on equipment handling media above 60 degrees F excluding the following:

a. Hydraulic Power Units.

b. Electrical Generator.

c. Air Compressor.

d. Compressed Air Drier.

e. Pumps handling media below 130 degrees F.

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3.4.3.1 Insulation

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Insulation shall be suitable for the temperature encountered. Insulation thickness for hot equipment shall be determined using Table IV

TABLE IV
Insulation Thickness for Hot Equipment (Inches)

Equipment handling media to indicated pressure or temperature limit:	Material	Thickness
15 psig	RMF	2.0 inches
or	FMF	2.0 inches
250F	CS/PL	4.0 inches
	CG	3.0 inches
	PF	1.5 inches
	FC (<200F)	1.0 inches
200 psig	RMF	3.0 inches
or	FMF	3.0 inches
400 F	CS/PL	4.0 inches
	CG	4.0 inches
600 F	RMF	5.0 inches
	FMF	6.0 inches
	CS/PL	6.0 inches
	CG	6.0 inches

>600 F: Thickness necessary to limit the external temperature of the insulation to 120F, except that diesel engine exhaust piping and mufflers shall be covered with 6.0 inch thick material suitable for 1200 degrees F service. Heat transfer calculations shall be submitted to substantiate insulation and thickness selection.

Legend

RMF: Rigid Mineral Fiber
FMF: Flexible Mineral Fiber
CS: Calcium Silicate
PL: Perlite
CG: Cellular Glass
FC: Flexible Cellular
PF: Phenolic Foam

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3.4.3.2 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not greater than 12 inch centers except flexible cellular which shall be adhered. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. On high vibration equipment, cellular glass insulation shall be set in a coating of bedding compound as recommended by the manufacturer, and joints shall be sealed with bedding compound. Mineral fiber joints shall be filled with finishing cement.

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d. Insulation on equipment requiring regular maintenance shall be removable. The removable section joint shall be fabricated using a male-female shiplap type joint. Entire surface of the removable section shall be finished as specified.

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e. Exposed insulation corners shall be protected with corner angles.

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f. NOT USED

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g. On equipment handling media above 600 degrees F, insulation shall be applied in two or more layers with joints staggered.

h. Upon completion of installation of insulation, penetrations shall be caulked. Two coats of adhesive shall be applied over insulation, including removable sections, with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking shall be applied to parting line between equipment and removable section insulation.

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15653

AIR-CONDITIONING SYSTEM (UNITARY TYPE)

08/00

-- End of Section Table of Contents --

SECTION 15653

AIR-CONDITIONING SYSTEM (UNITARY TYPE)
08/00

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 210/240	(1994) Unitary Air-Conditioning and Air-Source Heat Pump Equipment
ARI 270	(1995) Sound Rating of Outdoor Unitary Equipment
ARI 460	(1994) Remote Mechanical-Draft Air-Cooled Refrigerant Condensers
ARI 500	(1990) Variable Capacity Positive Displacement Refrigerant Compressors and Compressor Units for Air-Conditioning and Heat Pump Applications
ARI 700	(1995; Apx C) Specifications for Fluorocarbon and Other Refrigerants
ARI 710	(1995) Liquid-Line Driers
ARI 720	(1997) Refrigerant Access Valves and Hose Connectors
ARI 750	(1994) Thermostatic Refrigerant Expansion Valves
ARI 760	(1994) Solenoid Valves for Use with Volatile Refrigerants

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 307	(1997) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 653/A 653M	(1999) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated

	(Galvannealed) by the Hot-Dip Process
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM B 280	(1998) Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM C 1071	(1998) Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)
ASTM D 520	(1984; R 1995el) Zinc Dust Pigment
ASTM D 3308	(1997) PTFE Resin Skived Tape
ASTM F 104	(1995) Nonmetallic Gasket Materials

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 15	(1994) Safety Code for Mechanical Refrigeration
ASHRAE 34	(1997) Number Designation and Safety Classification of Refrigerants

ASME INTERNATIONAL (ASME)

ASME B31.5	(1992; B31.5a1994) Refrigeration Piping
ASME BPV VIII Div 1	(1998) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS Brazing Hdbk	(1991) Brazing Handbook
AWS A5.8	(1992) Filler Metals for Brazing and Braze Welding

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures
NEMA MG 1	(1998) Motors and Generators
NEMA MG 2	(1989) Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 207	(1993; Rev thru Oct 1997) Refrigerant-Containing Components and Accessories, Nonelectrical
UL 586	(1996; Rev thru Aug 99) High-Efficiency, Particulate, Air Filter Units
UL 900	(1994; Rev thru Apr 1997) Test Performance of Air Filter Units
UL 1995	(1995; Rev thru Jul 98) Heating and Cooling Equipment

1.2 PAYMENT

No separate payment shall be made items and work contained in this specification. Payment shall be incidental to bid item CONTROL BUILDINGS

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having a "FIO" designation are for information only. When used, a designation following the "GA" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Data

Air Handling Unit/Heat Pump System; GA, ED.

Manufacturer's standard catalog data, prior to the purchase or installation of a particular component, shall be highlighted to show brand name, model number, size, options, performance charts and curves, etc. in sufficient detail to demonstrate compliance with contract requirements. Data shall be submitted for each specified component. Data shall include manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations.

Spare Parts Data; GA, ED.

Spare parts data for each different item of equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

SD-04 Drawings

Air Handling Unit/Heat Pump System; GA, ED.

Drawings shall provide adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

(1) Equipment layouts which identify assembly and installation details.

(2) Piping layouts which identify valves and fittings.

(3) Plans and elevations which identify clearances required for maintenance and operation.

(4) Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

(5) Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

(6) Automatic temperature control diagrams and control sequences.

(7) Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

SD-06 Instructions

Framed Instructions; FIO

Framed instructions for posting, at least 2 weeks prior to construction completion.

SD-07 Schedules

Tests; GA, RE.

A letter, at least 10 working days in advance of each tests, advising the Contracting Officer of the test. Individual letters shall be submitted for refrigerant system, ductwork leak tests, and the system performance tests. Each letter shall identify the date, time, and location for each test.

Demonstrations; GA, RE.

A letter, at least 14 working days prior to the date of the proposed training course, which identifies the date, time, and location for the training.

SD-08 Statements

Verification of Dimensions; GA, RE

A letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found.

SD-09 Reports

Tests; GA, ED.

Six copies of each test containing the information described below in bound 8-1/2 x 11 inch booklets. Individual reports shall be submitted for the refrigerant system and ductwork leak tests.

(1) The date the tests were performed.

(2) A list of equipment used with calibration certifications.

(3) Initial test summaries.

(4) Repairs/adjustments performed.

(5) Final test results.

System Performance Tests; GA, ED.

Six copies of the report shall be provided in bound 8-1/2 x 11 inch booklets. The report shall document compliance with the specified performance criteria upon completion and testing of the system. The report shall indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. The report shall also include the following information and shall be taken at least three different times at outside dry-bulb temperatures that are at least 5 degrees F apart:

(1) Date, outside weather conditions,and environmental conditions inside equipment room.

(2) The load on the system based on the following:

(a) The refrigerant used in the system.
(b) Condensing temperature and pressure.
(c) Suction temperature and pressure.
(d) Ambient, condensing and coolant temperatures

(e) Running current, voltage, and proper phase sequence for each phase of all motors.

(3) The actual on-site setting of operating and safety controls.

(4) Thermostatic expansion valve superheat - value as determined by field test

(5) Subcooling

(6) Defrost system timer and thermostat set-points

(7) Moisture content of the air

(8) Field data and adjustments which affect unit performance and energy consumption.

(9) Field adjustments and settings which were not permanently marked as an integral part of a device.

Inspections; GA, RE.

Test report, at the completion of one year of service, in bound 8-1/2 x 11 inch booklets. The report shall identify the condition of the equipment. The report shall also include a comparison of the condition of the equipment with the manufacturer's recommended operating conditions.

SD-13 Certificates

Air Handling Unit/Heat Pump System; GA, RE.

Where the system, components, or equipment are specified to comply with requirements of ARI, ASHRAE, ASME, or UL, proof of such compliance shall be provided. The label or listing of the specified agency shall be acceptable evidence. In lieu of the label or listing, a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency may be submitted. When performance requirements of this project's drawings and specifications vary from standard ARI rating conditions, computer printouts, catalog, or other application data certified by ARI or a nationally recognized laboratory as described above shall be included. If ARI does not have a current certification program that encompasses such application data, the manufacturer may self certify that his application data complies with project performance requirements in accordance with the specified test standards.

Service Organizations; FIO.

A certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. The service organizations shall be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

Qualification of Welders and Welding Operators; GA, RE.

Certifications for welders and welding operators shall be submitted prior to commencing fabrication.

SD-19 Operation and Maintenance Manuals

Operation Manual; GA, ED.

Six complete copies of an operation manual in bound 8-1/2 x 11 inch booklets listing step-by-step procedures required for system startup, operation, and shutdown. The booklets shall include the manufacturer's name, model number, and parts list. The manuals shall include the manufacturer's name, model number, service manual, and a brief description of all equipment and their basic operating features.

Maintenance Manual; GA, ED.

Six complete copies of maintenance manual in bound 8-1/2 x 11 inch booklets listing routine maintenance procedures, possible breakdowns and repairs, and a trouble shooting guide. The manuals shall include piping and equipment layouts and simplified wiring and control diagrams of the system as installed.

1.4 Payment

No separate payment shall be made for work and equipment covered under the section. Payment for shall be included with bid item "Control Buildings".

1.5 Qualification of Welders and Welding Operators

Structural members shall be welded in accordance with Section 05055 WELDING, STRUCTURAL.

1.6 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather and contamination. Proper protection and care of all material before, during, and after installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.7.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, electrical, structural, and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions. Equipment, ductwork, and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

PART 2 PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to submittal date. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record shall be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

2.2 NAMEPLATES

Major equipment including air handling units, compressors, dryers, electric heating coils, fans, heat pumps, receivers, refrigerant coils, valves and motors shall have the manufacturer's name, type or style, model or serial number, on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of steel or aluminum. In the absence of a plate the required information may be stamped into the component. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

2.3 ELECTRICAL WORK

Electrical equipment, motors, motor efficiencies, and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall be as shown, and unless otherwise indicated, all motors of 1 horsepower and above with drip proof, or totally enclosed fan cooled enclosures, shall be high efficiency type. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Gaskets

Gaskets shall conform to ASTM F 104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

2.4.2 Bolts and Nuts

Bolts and nuts, except as required for piping applications, shall be in accordance with ASTM A 307. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A 307.

2.4.3 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69.

2.5 UNITARY EQUIPMENT, SPLIT SYSTEM

Unit shall be an air-cooled, split system which employs a remote condensing unit (heat pump), a separate indoor unit (air handling unit), and interconnecting refrigerant piping. Unit shall be the heat pump type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be rated in accordance with ARI 210/240. Unit shall be provided with necessary fans, air filters, coil frost protection, supplemental heat and pre-heat coil. The remote unit shall be as specified in paragraph REMOTE CONDENSING UNIT. Evaporator or supply fans shall be forward curved, backward inclined, or airfoil blade, centrifugal scroll type. Remote condensing unit fans shall be the manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Unit shall have two speed compressor and fans for energy savings. Units shall be the manufactures highest efficiency model.

2.5.1 Air-to-Refrigerant Coil

Coils shall have copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coils shall be protected with a minimum 3 mil thick phenolic or vinyl coating. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ASHRAE 15 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged.

2.5.2 Refrigeration Circuit

Refrigerant-containing components shall comply with ASHRAE 15. Air to refrigerant coils shall be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant charging valves and connections shall be provided for each circuit. Refrigeration lines connecting indoor and out door equipment shall be field fabricated, cut to exact length, pressure leak tested then vacuum evacuated. Filter-drier shall be provided in each liquid line and be reversible-flow type. Refrigerant flow control devices shall be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control, and a pilot solenoid controlled, leak-tight, four-way refrigerant flow reversing valve. Refrigeration circuit shall have strainers installed inline ahead of the refrigerant flow control device. Sight glass and liquid level indicator will be installed in each liquid line.

2.5.3 Unit Controls

Unit shall be internally prewired with a 24 volt control circuit powered by an internal transformer. Terminal blocks shall be provided for power wiring and external control wiring. Unit shall have cutoffs for high and low pressure and safety interlocks on all service panels. Head pressure controls shall sustain unit operation with ambient temperature ranging between 40 and 110 degrees F. Adjustable-cycle timers shall prevent short-cycling. Unit shall be internally protected by fuses or a circuit breaker in accordance with UL 1995.

2.5.4 Refrigerant and Oil

Refrigerant shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ASHRAE 34. Refrigerants shall meet the requirements of ARI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.05. Contractor shall provide and install a complete charge of refrigerant for the installed system as recommended by the manufacturer. Except for factory sealed units, two complete charges of lubricating oil for each compressor crankcase shall be furnished. One charge shall be used during the system performance testing period. Following the satisfactory completion of the performance testing, the oil shall be drained and replaced with a second charge. Lubricating oil shall be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge shall be in accordance with manufacturer's recommendation.

2.5.5 Fans

Fan wheel shafts shall be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans shall be selected to produce the cfm required at the fan total pressure. Motor starters, if applicable, shall be magnetic across-the-line type with a drip proof or totally enclosed enclosure. Thermal overload protection shall be of the manual or automatic-reset type. Fan wheels shall be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, shall be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting shall be recoated with an approved zinc-rich compound. Fan wheels shall be statically and dynamically balanced. Direct-drive fan motors shall be of the multiple-speed variety. Each drive will be independent of any other drive.

2.5.6 Electric Heating Coil

2.5.6.1 Pre-Heat Coil

Preheat coil shall be installed where indicated. Coil shall be an electric duct heater in accordance with UL 1995 and NFPA 70. Coil shall be duct-mounted. Coil shall be of the nickel chromium resistor, single stage, strip or stainless steel, fin tubular type. Coil shall be provided with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Coil casing and support brackets shall be of galvanized steel. Coil shall be mounted to eliminate noise from expansion and contraction and be completely accessible for service.

2.5.6.2 Supplemental Heat Coil

Supplemental heat coil shall be accordance with UL 1995 and NFPA 70. Coil shall be unit-mounted into the system air handling unit. It shall be manufactured for the particular unit to which it is mounted. Coil shall be of the nickel chromium resistor, single stage, strip type. Coil shall be provided with a built-in high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Coil mounting brackets shall be of standard manufacturer materials specific to the unit installed. Coil shall be mounted to eliminate noise from expansion and contraction and be completely accessible for service.

2.5.7 Air Filters

Air filters shall be listed in accordance with requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test Method shall be as listed under the label service and shall meet the requirements of UL 586.

2.5.8 Coil Frost Protection

Each refrigerant circuit shall be provided with a coil frost protection system which is a manufacturer's standard. The coil frost protection system shall use a temperature sensor in the suction line of the compressor to shut the compressor off when coil frosting occurs. Timers shall be used to prevent the compressor from rapid cycling.

2.5.9 Cabinet Construction

Casings for the specified unitary equipment shall be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces shall be 20 gauge galvanized steel or 0.064 inch thick aluminum on units with a capacity less than 20 tons. Casing shall be fitted with access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, condensate drip pan and drain, and internal insulation. Where double-wall insulated construction is proposed, minimum exterior galvanized sheet metal thickness shall be 20 gauge. Provisions to permit replacement of major unit components shall be incorporated. Penetrations of cabinet surfaces, including the floor, shall be sealed. Unit shall be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan shall be fabricated from Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation shall be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces shall prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation shall conform to ASTM C 1071. Paint and finishes shall comply with the requirements specified in paragraph "Factory Coating".

2.6 REMOTE CONDENSING UNIT

Units shall produce a maximum ARI sound rating of 76 db when rated in accordance with ARI 270. Saturated refrigerant condensing temperature shall not exceed 120 degrees F at 95 degrees F ambient. Fan and cabinet construction shall be provided as specified in paragraph "System Components". Fan motors shall have drip proof or totally enclosed enclosures.

2.6.1 Air-Cooled Condenser

Unit shall be rated in accordance with ARI 460 and conform to the requirements of UL 1995. Unit shall be factory fabricated, tested, packaged, and self-contained. Unit shall be complete with casing, propeller or centrifugal type fans, heat rejection coils, connecting piping and wiring, and all necessary appurtenances.

2.6.1.1 Connections

Interconnecting refrigeration piping, electrical power, and control wiring between the condensing unit and the indoor unit shall be provided as required and as indicated. Electrical and refrigeration piping terminal connections between condensing unit and evaporator units shall be provided.

2.6.1.2 Unit Controls

Unit mounted control panels or enclosures shall be constructed in accordance with applicable requirements of NFPA 70 and housed in NEMA ICS 6, Class 1 or 3A enclosures. Controls shall include control transformer, fan motor starters, time delay start-up, overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

2.6.2 Compressor

Unit shall be rated in accordance with ARI 500. Compressor shall be two speeddirect drive, hermetic reciprocating or scroll type capable of operating at partial load conditions. Compressor shall be capable of continuous operation. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor in which case the compressors will operate in sequence, and each compressor shall have an independent refrigeration circuit through the condensing unit and evaporator. Each compressor shall start with refrigerant pressures equalized across the head and suction sides. Each compressor shall be provided with vibration isolators, crankcase heater, thermal overloads, and high and low pressure safety cutoffs and protection against short cycling. Compressors shall two speed motors.

2.6.3 Pressure Vessels

Pressure vessels shall conform to ASME BPV VIII Div 1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Where referenced publications do not apply, pressure components shall be tested at 1-1/2 times design working pressure. Refrigerant wetted carbon steel surfaces shall be pickled or abrasive blasted free of mill scale, cleaned, dried, charged, and sealed.

2.6.4 Fans

Fan wheel shafts shall be supported by either maintenance-accessible lubricated antifriction block-type bearings or permanently lubricated ball bearings. Motor starters, if applicable, shall be magnetic across-the-line type with a drip proof or totally enclosed enclosure. Thermal overload protection shall be of the manual or automatic-reset type. Fan wheels or propellers shall be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings shall be of galvanized steel, and both centrifugal and propeller fan casings shall be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, shall be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting shall be recoated with an approved zinc-rich compound. Fan wheels or propellers shall be statically and dynamically balanced. Direct-drive fan motors shall be of the multiple-speed variety. Centrifugal scroll-type fans shall be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. Propeller fans shall be direct-drive drive type with fixed pitch blades. Each drive will be independent of any other drive. Drive bearings shall be protected with water slingers or shields.

2.6.5 Cabinet

Outdoor cabinets shall be suitable for outdoor service with a weathertight, insulated and corrosion-protected structure. Cabinets constructed exclusively for indoor service which have been modified for outdoor service are not acceptable. Casings for the specified unitary equipment shall be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces shall be 20 gauge galvanized steel or 0.064 inch thick aluminum. Casing shall be fitted with access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, condensate drain. Provisions to permit replacement of major unit components shall be incorporated. Paint and finishes shall comply with the requirements specified in paragraph "Factory Coating".

2.7 REFRIGERANT SIGNS

Refrigerant signs shall be a medium-weight aluminum type with a baked enamel finish. Signs shall be suitable for indoor or outdoor service. Signs shall have a white background with red letters not less than 0.5 inches in height.

2.7.1 Installation Identification

Each new refrigeration system shall be provided with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name
b. Refrigerant number and amount of refrigerant.
c. The lubricant identity and amount.
d. Field test pressure applied.

2.8 INSULATION

Field installed insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.9 TEMPERATURE CONTROLS

Each system shall operate from individual thermostats located as indicted. Thermostats shall be rated for 24V. Thermostats shall provide two stage cooling and three stage heating. They shall automatically switch between heating and cooling modes. Each thermostat shall display room temperature, current mode of operation, and the setpoints.

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2.10 DUCTWORK COMPONENTS

2.10.1 Metal Ductwork

Metal ductwork shall be provided as specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

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2.11 REFRIGERANT PIPING

Refrigerant piping, valves, fittings, and accessories shall conform to the requirements of ASHRAE 15 and ASME B31.5, except as specified.

2.11.1 Copper Tubing

Copper tubing shall conform to ASTM B 280 annealed or hard drawn as required. Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing shall not be used in sizes larger than 1-3/8 inches. Joints shall be brazed except that joints on lines 7/8 inch and smaller may be flared.

2.11.2 Joints and Fittings, Copper Tubing

Copper tube joints and fittings shall be flare joint type with short-shank flare or solder-joint pressure type. Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings shall not be allowed for brazed joints.

2.11.3 Valves

Valves shall be pressure and temperature rated for contained refrigerant service and shall comply with ASME B31.5. Metals of construction shall be ferrous or copper based. Atmosphere exposed valve stems shall be stainless steel or corrosion resistant metal plated carbon steel. Valve body connections shall be brazed or welded socket, flanged or combination thereof. Threaded connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Valves shall be suitable for or fitted with extended copper ends for brazing in-place without disassembly. Ferrous body valves shall be fitted with factory fabricated and brazed copper transitions. To minimize system pressure drops, where practicable, globe valves shall be angle body type, and straight line valves shall be full port ball type. Control valve inlets shall be fitted with integral or adapted strainer or filter where recommended or required by manufacturer. Valves shall be cleaned and sealed moisture-tight.

2.11.3.1 Liquid Solenoid Valves

Valves shall comply with ARI 760 and be suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves shall be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions shall be furnished. Solenoid coils shall be moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves shall have safe working pressure of 400 psi and a maximum operating pressure differential of at least 200 psi at 85 percent rated voltage. Valves shall have an operating pressure differential suitable for the refrigerant used.

2.11.3.2 Expansion Valves

Expansion valves conform to requirements of ARI 750. Valve shall be of the diaphragm and spring type with external equalizers, and bulb and capillary tubing. Valve shall be provided with an external superheat adjustment along with a seal cap. Bulb charge shall be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Gas limited liquid charged valves and other valve devices for limiting evaporator pressure shall not be used without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves shall have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line.

2.11.3.3 Refrigerant Access Valves

Refrigerant access valves and hose connections shall be in accordance with ARI 720.

2.11.3.4 Filter Driers

Driers shall conform to ARI 710. Sizes 5/8 inch and larger shall be the full flow, replaceable core type. Sizes 1/2 inch and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 1,500 psi.

2.11.3.5 Sight Glass and Liquid Level Indicator

a. Assembly and Components: Assembly shall be pressure- and temperature-rated and constructed of materials suitable for the service. Glass shall be borosilicate type. Ferrous components subject to condensation shall be electro-galvanized.

b. Gauge Glass: Gauge glass shall include top and bottom isolation valves fitted with automatic checks and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

c. Bull's-Eye and Inline Sight Glass Reflex Lens: Bull's-eye and inline sight glass reflex lens shall be provided for dead-end liquid service. For pipe line mounting, two plain lenses in one body suitable for backlighted viewing shall be provided.

d. Moisture Indicator: Indicator shall be a self-reversible action, moisture reactive, color changing media. Indicator shall be furnished with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator shall be an integral part of each corresponding sight glass.

2.11.3.6 Strainers

Strainers used in refrigerant service shall have brass or cast iron body, Y-or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe diameter with pressure rating compatible with the refrigerant service. Screens shall be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

2.11.3.7 Brazing Materials

Brazing materials for refrigerant piping shall be in accordance with AWS A5.8, Classification BCuP-5.

2.12 DRAIN AND MISCELLANEOUS PIPING

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Piping, fittings, valves, and accessories for drain and miscellaneous services shall be in accordance with Section 15400

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2.13 FACTORY COATINGS

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 125 hours exposure to the salt spray test specified in ASTM B 117 using a 25 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPV VIII Div 1 and ASME BPV IX, the design, fabrication, and installation of the system shall conform to ASME BPV VIII Div 1 and ASME BPV IX.

3.1.1 Equipment

Refrigeration equipment and the installation thereof shall conform to ASHRAE 15. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required. Compressors shall be mounted on manufacturer standard vibration isolators. Condensing unit shall isolated from the building structure, see details in contract plans. Vibration absorbing foundations shall be provided. Each foundation shall include isolation units.

3.1.2 Equipment Room and Restroom Ventilation

Mechanical ventilation systems shall be in accordance with Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM.

3.1.3 Building Surface Penetrations

Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A 653/A 653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be prepared framed openings. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

3.1.3.1 General Service Areas

Each opening shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07900 JOINT SEALING.

3.1.3.2 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07840 FIRESTOPPING.

3.1.4 Access Panels

Access panels shall be provided for all concealed valves vents, controls, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METALS.

3.1.5 General Piping Installation

3.1.5.1 Brazed Joints

Brazing shall be performed in accordance with AWS Brazing Hdbk, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Joints in steel tubing shall be painted with the same material as the baked-on coating within 8 hours after joints are made. Tubing shall be protected against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Piping shall be supported prior to brazing and not be sprung or forced.

3.1.5.2 Threaded Joints

Threaded joints shall be made with tapered threads and made tight with PTFE tape complying with ASTM D 3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

3.1.5.3 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.6 Refrigeration Piping

Unless otherwise specified, pipe and fittings installation shall conform to requirements of ASME B31.5. Pipe shall be cut accurately to measurement established at the jobsite and worked into place without springing or forcing. Cutting or otherwise weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipes shall be cut square, shall have burrs removed by reaming, and shall be installed in a manner to permit free expansion and contraction without damage to joints or hangers. Filings, dust, or dirt shall be wiped from interior of pipe before connections are made.

3.1.6.1 Directional Changes

Changes in direction shall be made with fittings or by bending of pipe, provided a pipe bender is used and wide-sweep bends are formed. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, or other malformations will not be accepted.

3.1.6.2 Functional Requirements

Piping shall be installed 1/2 inch per 10 feet of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings.

3.1.6.3 Expansion Valves

Expansion valves shall be installed with the thermostatic expansion valve bulb located on top of the suction line The bulb shall be securely fastened with two clamps. The bulb shall be insulated. The bulb shall installed in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing shall be facing up.

3.1.6.4 Valve Identification

Each system valve, including those which are part of a factory assembly, shall be tagged. Tags shall be in alphanumeric sequence, progressing in direction of fluid flow. Tags shall be embossed, engraved, or stamped plastic or nonferrous metal of various shapes, sized approximately 1-3/8 inch diameter, or equivalent dimension, substantially attached to a component or immediately adjacent thereto. Tags shall be attached with nonferrous, heavy duty, bead or link chain, 14 gauge annealed wire, nylon cable bands or as approved. Tag numbers shall be referenced in Operation and Maintenance Manuals and system diagrams.

3.1.6.5 Filter Dryer

A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Dryers shall be sized in accordance with the manufacturers recommendations. A dryer shall be installed such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

3.1.6.6 Sight Glass

A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of filter dryers and where indicated. Sight glass shall be full line size.

3.1.7 Piping Supports

Refrigerant pipe supports shall be in accordance with ASME B31.5. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.7.1 Seismic Requirements

Piping and attached valves shall be supported and braced to resist seismic loads as specified under Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT . Structural steel required for reinforcement to properly support piping, headers, and equipment but not shown shall be provided under this section. Material used for support shall be as specified under Section 05120 STRUCTURAL STEEL.

3.1.7.2 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Material used for support shall be as specified under Section 05120 STRUCTURAL STEEL.

3.1.8 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used.

3.1.8.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.1.8.2 Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.1.8.3 C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.1.8.4 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

3.1.8.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

3.1.8.6 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.

3.1.8.7 Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feetfrom end of risers, and at vent terminations.

3.1.8.8 Pipe Guides

Type 35 guides using steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.1.8.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle shall be used. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.8.10 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.1.9 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.1.10 Pipe Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface to provide essentially zero movement within penetration seal. Detailed drawings of pipe anchors shall be submitted for approval before installation.

3.1.11 Pipe Color Code Marking

Color code marking of piping shall be as specified in Section 09900 PAINTING, GENERAL.

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3.1.12 Ductwork

Ductwork and Ductwork accessories shall be installed as specified in Section 15895, AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

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3.1.13 Field Applied Insulation

Field applied insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.14 Framed Instructions

Framed instructions shall be framed under glass or laminated plastic and be posted where directed. Instructions shall include equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions. The condensed operation instructions shall include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The instructions shall be posted before acceptance testing of the system.

3.2 TESTS

Tests shall be conducted in the presence of the Contracting Officer. Utilities for testing shall be provided as specified in the SPECIAL CONTRACT REQUIREMENTS. Water and electricity required for the tests will be furnished by the Government. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. The services of a qualified technician shall be provided as required to perform all tests and procedures indicated herein. Field tests shall be coordinated with Section 15990 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.2.1 Refrigerant System

After all components of the refrigerant system have been installed and connected, the entire refrigeration system shall be subjected to a pneumatic test as described herein.

3.2.1.1 Preliminary Procedures

Prior to pneumatic testing, equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, shall be isolated from the test pressure or removed from the system. Safety relief valves and rupture discs, where not part of factory sealed systems, shall be removed and openings capped or plugged.

3.2.1.2 Pneumatic Test

Pressure control and excess pressure protection shall be provided at the source of test pressure. Valves shall be wide open, except those leading to the atmosphere. Test gas shall be dry nitrogen, with minus 70 degree F dewpoint and less than 5 ppm oil. Test pressure shall be applied in two stages before any refrigerant pipe is insulated or covered. First stage test shall be at 10 psi with every joint being tested with a thick soap or color indicating solution. Second stage tests shall raise the system to the minimum refrigerant leakage test pressure specified in ASHRAE 15 with a maximum test pressure 25 percent greater. Pressure above 100 psig shall be raised in 10 percent increments with a pressure acclimatizing period between increments. The initial test pressure shall be recorded along with the ambient temperature to which the system is exposed. Final test pressures of the second stage shall be maintained on the system for a minimum of 24 hours. At the end of the 24 hour period, the system pressure will be recorded along with the ambient temperature to which the system is exposed. A correction factor of 0.3 psi will be allowed for each degree F change between test space initial and final ambient temperature, plus for increase and minus for a decrease. If the corrected system pressure is not exactly equal to the initial system test pressure, then the system shall be investigated for leaking joints. To repair leaks, the joint shall be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, remelting, or back-welding/brazing shall not be acceptable. Following repair, the entire system shall be retested using the pneumatic tests described above. The entire system shall be reassembled once the pneumatic tests are satisfactorily completed.

3.2.1.3 Evacuation Test

Following satisfactory completion of the pneumatic tests, the pressure shall be relieved and the entire system shall be evacuated to an absolute pressure of 300 micrometers. During evacuation of the system, the ambient temperature shall be higher than 35 degrees F. No more than one system shall be evacuated at one time by one vacuum pump. Once the desired vacuum has been reached, the vacuum line shall be closed and the system shall stand for 1 hour. If the pressure rises over 500 micrometers after the 1 hour period, then the system shall be evacuated again down to 300 micrometers and let set for another 1 hour period. The system shall not be charged until a vacuum of at least 500 micrometers is maintained for a period of 1 hour without the assistance of a vacuum line. If during the testing the pressure continues to rise, check the system for leaks, repair as required, and repeat the evacuation procedure. During evacuation, pressures shall be recorded by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

3.2.1.4 System Charging and Startup Test

Following satisfactory completion of the evacuation tests, the system shall be charged with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures. Following charging, the system shall operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. The entire system shall be tested for leaks. Fluorocarbon systems shall be tested with halide torch or electronic leak detectors.

3.2.1.5 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

3.2.1.6 Contractor's Responsibility

The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

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3.2.2 NOT USED

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3.2.3 System Performance Tests

After the foregoing tests have been completed and before each refrigeration system is accepted, tests to demonstrate the general operating characteristics of all equipment shall be conducted by a registered professional engineer or an approved manufacturer's start-up representative experienced in system start-up and testing, at such times as directed. Tests shall cover a period of not less than 48 hours for each system and demonstrate that the entire system is functioning in accordance with the drawings and specifications. Corrections and adjustments shall be made as necessary and tests shall be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, service valve seal caps and blanks over gauge points shall be installed and tightened. Any refrigerant lost during the system startup shall be replaced. If tests do not demonstrate satisfactory system performance, deficiencies shall be corrected and the system shall be retested.

3.3 INSPECTIONS

At the conclusion of the one year period, cooling towers and condensers shall be inspected for problems due to corrosion, scale, and biological growth. If the cooling tower and condenser are found not to conform to the manufacturers recommended conditions, assuming the water treatment company recommendations have been followed, the water treatment company shall provide all chemicals and labor for cleaning or repairing the equipment as required by the manufacturer's recommendations.

3.4 CLEANING AND ADJUSTING

3.4.1 Piping

Prior to testing, pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from each water system through the use of the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented.

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3.4.2 NOT USED

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3.4.3 Equipment

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. System shall be maintained in this clean condition until final acceptance. Bearings shall be lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed.

3.4.4 Testing, Adjusting, and Balancing

Testing, adjusting, and balancing shall be as specified in Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS.

3.5 DEMONSTRATIONS

Contractor shall conduct a training course for the operating staff as designated by the Contracting Officer. The training period shall consist of a total 1 hours of normal working time and start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations. -- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM

02/94

-- End of Section Table of Contents --

SECTION 15895

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI Guideline D	(1996) Application and Installation of Central Station Air-Handling Units

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 210	(1985) Laboratory Methods of Testing Fans for Rating
AMCA 300	(1996) Reverberant Room Method for Sound Testing of Fans

AMERICAN BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA Std 11	(1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 924/A 924M	(1997a) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 117	(1997) Operating Salt Spray (FOG) Apparatus
ASTM D 520	(1984; R 1995) Zinc Dust Pigment
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 3359	(1997) Measuring Adhesion by Tape Test

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(1993; Rev 1; Rev 2; Rev 3; Rev 4) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(1996) Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Install Fire Damp HVAC	(1992) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
SMACNA HVAC Duct Const Stds	(1995; Addenda Nov 1997) HVAC Duct Construction Standards - Metal and Flexible
SMACNA Leakage Test Mnl	(1985) HVAC Air Duct Leakage Test Manual

UNDERWRITERS LABORATORIES (UL)

UL 181	(1996; Rev Dec 1998) Factory-Made Air Ducts and Air Connectors
UL 214	(1997) Tests for Flame-Propagation of Fabrics and Films
UL 555	(1999) Fire Dampers
UL Bld Mat Dir	(1998) Building Materials Directory
UL Elec Const Dir	(1998) Electrical Construction Equipment Directory
UL Fire Resist Dir	(1998) Fire Resistance Directory (2 Vol.)

1.2 COORDINATION OF TRADES

Ductwork, piping offsets, fittings, and accessories shall be furnished as required to provide a complete installation and to eliminate interference with other construction.

1.3 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.4 PAYMENT

No separate payment shall be made items and work contained in this specification. Payment shall be incidental to bid item CONTROL BUILDINGS

1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Data

Components and Equipment Data; GA, ED.

Manufacturer's catalog data shall be included with the detail drawings for the following items. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:

a. Ductwork Components

b. Air Systems Equipment

c. Air Handling Units

SD-04 Drawings

Air Supply, Distribution, Ventilation, and Exhaust Equipment; FIO.

Drawings shall consist of equipment layout including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of all guides and anchors, the load imposed on each support or anchor, and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

SD-06 Instructions

Test Procedures; GA, ED.

Proposed test procedures for piping hydrostatic test, ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

System Diagrams; GA, ED.

Proposed diagrams, at least 4 weeks prior to start of related testing. System diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

SD-07 Schedules

Test Schedules; GA, RE.

Proposed test schedules for ductwork leak test, and performance tests, at least 2 weeks prior to the start of related testing.

Field Training Schedule; GA, RE.

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

SD-08 Statements

Similar Services; GA, RE.

Statement demonstrating successful completion of similar services on at least 5 projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section.

SD-09 Reports

Test Reports; GA, ED.

Test reports for the ductwork leak test, and performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

SD-13 Certificates

Bolts; FIO.

Written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings and the number of each type of bolt to be furnished.

SD-19 Operation and Maintenance Manuals

Air Supply, Distribution, Ventilation, and Exhaust Manuals; GA, ED.

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4 hour on site response to a service call on an emergency basis 24 hours a day.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Components and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to submittal of product information. The 2-year experience shall include applications of components and equipment under similar circumstances and of similar size. The 2 years must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization.

2.2 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.

2.3 NAMEPLATES

Equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.4 EQUIPMENT GUARDS AND ACCESS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified.

2.5 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be according to Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 1 hp and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided. Where two-speed or variable-speed motors are indicated, solid-state variable-speed controller may be provided to accomplish the same function. Solid-state variable-speed controllers shall be utilized for motors rated 10 hp or less. Adjustable frequency drives shall be used for larger motors.

2.6 CONTROLS

Controls shall be provided as specified in Section 15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS.

2.7 DUCTWORK COMPONENTS

2.7.1 Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA HVAC Duct Const Stds unless otherwise specified. Elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure Class 1/2, 1, and 2 inch w.g. ductwork shall meet the requirements of Seal Class C. Class 3 inch w.g. shall meet the requirements of Seal Class A. Sealants shall conform to fire hazard classification specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA HVAC Duct Const Stds. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar will not be acceptable. Outdoor air intake ducts and plenums shall be fabricated with watertight soldered or brazed joints and seams.

2.7.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees unless otherwise indicated. Transitions for converging air flow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle need not comply with the maximum angles specified.

2.7.1.2 General Service Duct Connectors

A flexible duct connector approximately 6 inches in width shall be provided where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL Bld Mat Dir.

2.7.1.3 High Temperature Service Duct Connections

Material shall be approximately 3/32 inch thick, 35 to 40-ounce per square yardweight, plain weave fibrous glass cloth with nickel/chrome wire reinforcement for service in excess of 1200 degrees F.

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2.7.2 Non-Metallic Ductwork

2.7.2.1 Insulated Nonmetallic Flexible Duct Runouts

Flexible duct runouts shall be used only where indicated. Runouts shall not exceed 10 feet in length, shall be preinsulated, factory fabricated, and comply with NFPA 90A and UL 181. Either field or factory applied vapor barrier shall be provided. Where coil induction or high velocity units are supplied with vertical air inlets, a streamlined and vaned and mitered elbow transition piece shall be provided for connection to the flexible duct or hose. The last elbow to these units, other than the vertical air inlet type, shall be a die-stamped elbow and not a flexible connector. Insulated flexible connectors may be used as runouts. The insulation material surface shall not be exposed to the air stream.

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2.7.3 Ductwork Accessories

2.7.3.1 Duct Access Doors

Access doors shall be provided in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown, shall conform to SMACNA HVAC Duct Const Stds. Access doors shall be provided upstream and downstream of air flow measuring primaries and heating and cooling coils. Doors shall be minimum 15 x 18 inches, unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Doors 24 x 24 inches or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be the insulated type.

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2.7.3.2 Fire Dampers

Fire dampers shall be 1-1/2 hour fire rated unless otherwise indicated. Fire dampers shall conform to the requirements of NFPA 90A and UL 555. Fire dampers shall be automatic operating type and shall have a dynamic rating suitable for the maximum air velocity and pressure differential to which it will be subjected. Fire dampers shall be approved for the specific application and shall be installed according to their listing. Fire dampers shall be equipped with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, will not impair the operation of the damper. Sleeves or frames shall be equipped with perimeter mounting angles attached on both sides of the wall or floor opening. Ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce the ceiling of the assemblies shall be constructed in conformance with UL Fire Resist Dir.

Fire dampers shall be curtain type with damper blades in the air stream. Dampers shall not reduce the duct or the air transfer opening cross-sectional area. Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

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2.7.4 Duct Sleeves, Framed Prepared Openings, Closure Collars

2.7.4.1 Duct Sleeves

Ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 20 gauge galvanized steel, unless otherwise indicated. Sleeve shall provide 1 inch clearance between the duct and the sleeve or 1 inch clearance between the insulation and the sleeve for insulated ducts.

2.7.4.2 Framed Prepared Openings

Openings shall have 1 inch clearance between the duct and the opening or 1 inch clearance between the insulation and the opening for insulated ducts.

2.7.4.3 Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 4 inches wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 15 inches in diameter or less shall be fabricated from 20 gauge galvanized steel. Collars for round ducts larger than 15 inches and square and rectangular ducts shall be fabricated from 18 gaugegalvanized steel. Collars shall be installed with fasteners on maximum 6 inch centers, except that not less than 4 fasteners shall be used.

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2.7.5 Diffusers, Registers, and Grilles

Units shall be factory-fabricated of steel, corrosion-resistant steel, or aluminum and shall distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Outlets for diffusion, spread, throw, and noise level shall be as required for specified performance. Performance shall be certified in accordance with ADC 1062:GRD. Inlets and outlets shall be sound rated and certified in accordance with ADC 1062:GRD. Sound power level shall be as indicated. Diffusers and registers shall be provided with volume damper with accessible operator, unless otherwise indicated, or if standard with the manufacturer, an automatically controlled device will be acceptable.

Volume dampers shall be opposed blade type for all diffusers and registers, except linear slot diffusers. Linear slot diffusers shall be provided with round or elliptical balancing dampers. Where the inlet and outlet openings are located less than 7 feet above the floor, they shall be protected by a grille or screen in accordance with NFPA 90A.

2.7.5.1 Diffusers

Diffuser types shall be as indicated. Ceiling mounted units shall be furnished with antismudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Diffusers shall be provided with air deflectors of the type indicated. Air handling troffers or combination light and ceiling diffusers shall conform to the requirements of UL Elec Const Dir for the interchangeable use as cooled or heated air supply diffusers or return air units. Ceiling mounted units shall be installed with rims tight against ceiling. Sponge rubber gaskets shall be provided between ceiling and surface mounted diffusers for air leakage control. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and shall not interfere with volume controller. Return or exhaust units shall be similar to supply diffusers.

2.7.5.2 Registers and Grilles

Floor units for installation in raised floor assemblies shall be the standard type from the floor manufacturer. Other units shall be four-way directional-control type, except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 6 inches below the ceiling unless otherwise indicated. Return and exhaust registers shall be located 6 inches above the floor unless otherwise indicated. Four-way directional control may be achieved by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Grilles shall be as specified for registers, without volume control damper.

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2.7.6 Louvers

Louvers shall be furnished for installation in exterior walls which are directly connected by ductwork to air handling equipment. Louvers shall be installed where shown. Louvers shall conform to the required of Section 10200 FIXED METAL LOUVERS.

2.8 AIR SYSTEMS EQUIPMENT

2.8.1 Fans

Fans shall be tested and rated according to AMCA 210. Fans may be connected to the motors either directly or indirectly with V-belt drive. V-belt drives shall be designed for not less than 140 percent of the connected driving capacity. Motor sheaves shall be variable pitch for 15 hp and below and fixed pitch as defined by ARI Guideline D. Variable pitch sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, a replaceable sheave shall be provided when needed to achieve system air balance. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts. Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings as indicated. Vibration-isolation units shall be standard products with published loading ratings. Each fan shall be selected to produce the capacity required at the fan static pressure indicated while sound power level. The sound power level values shall be obtained according to AMCA 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated.

2.8.1.1 Centrifugal Fans

Centrifugal fans shall be fully enclosed, single-width single-inlet, AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Impeller wheels shall be rigidly constructed and accurately balanced both statically and dynamically. Fan blades may be forward curved, backward-inclined, or airfoil design in wheel sizes up to 30 inches. Fan blades for wheels over 30 inches in diameter shall be backward-inclined or airfoil design. Fan wheels over 36 inches in diameter shall have overhung pulleys and a bearing on each side of the wheel. Fan wheels 36 inches or less in diameter may have one or more extra long bearings between the fan wheel and the drive. Bearings shall be sleeve type, self-aligning and self-oiling with oil reservoirs or precision self-aligning roller or ball-type with accessible grease fittings or permanently lubricated type. Grease fittings shall be connected to tubing and serviceable from a single accessible point. Bearing life shall be L50 rated at not less than 200,000 hours as defined by AFBMA Std 9 and AFBMA Std 11. Fan shafts shall be steel, accurately finished, and shall be provided with key seats and keys for impeller hubs and fan pulleys. Each fan outlet shall be of ample proportions and shall be designed for the attachment of angles and bolts for attaching flexible connections. Motors, unless otherwise indicated, shall not exceed 1800 ram and shall have totally enclosed enclosures. Motor starters shall be magnetic or across-the-line reduced-voltage-start type with general-purpose enclosure.

2.8.1.2 Panel Type Power Wall Ventilators

Fans shall be propeller type, assembled on a reinforced metal panel with venturi opening spun into panel. Fans with wheels less than 24 inches diameter shall be direct or V-belt driven and fans with wheels 24 inches diameter and larger shall be V-belt drive type. Fans shall be furnished with wall mounting collar. Lubricated bearings shall be provided. Fans shall be fitted with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Motor enclosure shall be drip proof or totally enclosed fan cooled type. Motor operated backdraft dampers shall be provided where indicated.

2.8.1.3 Ceiling Exhaust Fans

Suspended cabinet-type ceiling exhaust fans shall be centrifugal type, direct-driven. Fans shall have acoustically insulated housing. Integral backdraft damper shall be chatter-proof. The integral face grille shall be of egg-crate design or louver design. Fan motors shall be mounted on vibration isolators. Unit shall be provided with mounting flange for hanging unit from above. Fans shall be U.L. listed.

2.9 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123/A 123M or ASTM A 924/A 924M shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphatized and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of 125 hours for units to be installed indoors and 500 hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than 6, average creepage not greater than 1/8 inch. Rating of the inscribed area shall not be less than 10, no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through from the interior shall receive a final shop docket of zinc-rich protective paint according to ASTM D 520 Type I.

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.

3.1.1 Equipment and Installation

Frames and supports shall be provided for fans, coils, dampers, and other similar items requiring supports. Equipment mounted on mezzanine grating, unless otherwise indicated, shall be set 1/4 inch stainless steel plate that is securely bolted to the grating. A vibration isolator of the type indicated on sheet M-42 shall be placed between the equipment and the steel plate. The isolator shall be securely attached to the equipment and the steel plate. The contractor will size the isolator for the load and operating frequencies of the selected equipment. Piping and electrical conduits connected to the equipment shall be provided with flexible connections.

3.1.2 Access Panels

Access panels shall be provided for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METALS.

3.1.3 Flexible Connectors

Flexible connectors and flexible duct shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

3.1.4 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct insulation shall be packed as specified in Section 07840 FIRESTOPPING for fire rated penetrations. For non-fire rated penetrations, the space shall be packed as specified in Section 07900 JOINT SEALING.

3.1.5 Metal Ductwork

Installation shall be according to SMACNA HVAC Duct Const Stds unless otherwise indicated. Duct supports for sheet metal ductwork shall be according to SMACNA HVAC Duct Const Stds, unless otherwise specified. Friction beam clamps indicated in SMACNA HVAC Duct Const Stds shall not be used. Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion. Supports on the risers shall allow free vertical movement of the duct. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

3.1.6 Dust Control

To prevent the accumulation of dust, debris, and foreign material during construction, temporary dust control protection shall be provided. The distribution system (supply and return) shall be protected with temporary seal-offs at all inlets and outlets at the end of each day's work. Temporary protection shall remain in place until system is ready for startup.

3.1.7 Insulation

Thickness and application of insulation materials for ductwork, piping, and equipment shall be according to Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Outdoor air intake ducts and plenums shall be externally insulated .

3.1.8 Duct Test Holes

Holes with closures or threaded holes with plugs shall be provided in ducts and plenums where necessary for the use of pitot tube in balancing the air system. Extensions, complete with cap or plug, shall be provided where the ducts are insulated.

3.1.9 Power Transmission Components Adjustment

V-belts and sheaves shall be tested for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Belts on drive side shall be uniformly loaded, not bouncing. Alignment of direct driven couplings shall be to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.2 FIELD PAINTING AND COLOR CODE MARKING

Finish painting of items only primed at the factory, surfaces not specifically noted otherwise, and color code marking for piping shall be as specified in Section 09900 PAINTING, GENERAL.

3.3 DUCTWORK LEAK TEST

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Ductwork leak test shall be performed AHU-1, AHU-2, SF-1 and REMOTE RADIATOR . Test procedure, apparatus, and report shall conform to SMACNA Leakage Test Mnl. The maximum allowable leakage rates are:AHU-1 and AHU-2 100 CFM, SF-1 120 cfm, REMOTE RADIATOR 260 cfm. Ductwork leak test shall be completed with satisfactory results prior to applying insulation to ductwork exterior for exposed duct work.

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3.4 CLEANING AND ADJUSTING

Inside of ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean with traces of oil, dust, dirt, or paint spots removed. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.5 TESTING, ADJUSTING, AND BALANCING

Testing, adjusting, and balancing shall be as specified in Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS. Testing, adjusting, and balancing shall begin only when the air supply and distribution, including controls, has been completed with the exception of performance tests.

3.6 PERFORMANCE TESTS

After testing, adjusting, and balancing has been completed as specified, each system shall be tested as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by an experienced engineer. Tests shall cover a period of not less than 2 days for each system and shall demonstrate that the entire system is functioning according to the specifications. Coincidental chart recordings shall be made at points indicated on the drawings for the duration of the time period and shall record the temperature at space thermostats or space sensors, the humidity at space humidistats or space sensors, and the ambient temperature and humidity in a shaded and weather protected area.

3.7 FIELD TRAINING

The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 16 hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15950

HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS

08/96

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SECTION 15950

HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS
08/96

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 500-D	(1997) Laboratory Methods of Testing Dampers for Rating

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

UNDERWRITERS LABORATORIES (UL)

UL 508	(1993; Rev thru Oct 1997) Industrial Control Equipment

1.2 PAYMENT

No separate payment shall be made items and work contained in this specification. Payment shall be incidental to bid item CONTROL BUILDINGS

1.3 GENERAL REQUIREMENTS

1.3.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

1.3.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall furnish all work necessary to meet such conditions.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment Compliance Booklet; GA, ED.

An HVAC control system equipment compliance booklet (ECB) in indexed booklet form with numbered tabs separating the information on each device. It shall consist of, but not be limited to, data sheets and catalog cuts which document compliance of all devices and components with the specifications. The ECB shall be indexed in alphabetical order by the unique identifiers. Devices and components which do not have unique identifiers shall follow the devices and components with unique identifiers and shall be indexed in alphabetical order according to their functional name. The ECB shall include a bill of materials for each HVAC control system. The bill of materials shall function as the table of contents for the ECB and shall include the device's unique identifier, device function, manufacturer, model/part/catalog number used for ordering, and tab number where the device information is located in the ECB.

SD-04 Drawings

HVAC Control System; GA,ED.

Drawings on A1 8 by 11.5 inch sheets. The drawings shall use the same device identifiers shown. Each control-system element on a drawing shall have a unique identifier. All HVAC control system drawings shall be delivered together as a complete submittal. Drawings shall be submitted for each HVAC system.

a. HVAC control system drawings shall include the following:

Sheet One: Drawing index, HVAC control system legend.

Sheet Two: Damper schedule.

Sheet Three: HVAC control system schematic and equipment schedule.

Sheet Four: HVAC control system sequence of operation and ladder diagram.

Sheet Five: Motor starter and relay wiring diagram.

Note: Repeat sheets three through five for each AHU and Ventilation system.

b. An HVAC control system drawing index showing the name of the building, project site, city, and State. The drawing index shall list all HVAC control system drawings, including the drawing number, sheet number, drawing title, and computer filename when used.

c. An HVAC control system legend showing generic symbols and the name of devices shown on the HVAC control system drawings.

d. A damper schedule showing each damper and actuator's identifier, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, spring ranges, operation rate, positive positioners ranges, locations of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. The damper schedule shall include the maximum leakage rate at the operating static-pressure differential. The damper schedule shall contain actuator selection data supported by calculations of the torque required to move and seal the dampers, access and clearance requirements.

e. An HVAC control system equipment schedule showing device unique identifier, device function, setpoint, input range, and additional important parameters (i.e. output range).

f. An HVAC control system sequence of operation.

g. An HVAC control system ladder diagram showing all relays, contacts, switches, fuses and starters connected to the control system.

h. HVAC control system wiring diagrams showing functional wiring diagrams of the interconnection of conductors and cables to HVAC systems control terminal blocks and to the identified terminals of devices, starters and package equipment. The wiring diagrams shall show all necessary jumpers and ground connections. The wiring diagrams shall show the labels of all conductors. Sources of power required for HVAC control systems and for packaged-equipment control systems shall be identified back to the panel-board circuit breaker number, magnetic starter, or packaged equipment control circuit. Each power supply and transformer not integral to starter, or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown.

SD-08 Statements

Commissioning Procedures; GA, ED.

a. Six copies of the HVAC control system commissioning procedures, in indexed booklet form, 60 days prior to the scheduled start of commissioning. Commissioning procedures shall be provided for each HVAC systems controls, and for each type of terminal-unit control system. The commissioning procedures shall reflect the format and language of this specification, and refer to devices by their unique identifiers as shown. The commissioning procedures shall be specific for each HVAC system, and shall give detailed step-by-step procedures for commissioning of the system.

b. Commissioning procedures documenting detailed, product-specific set-up procedures, configuration procedures, adjustment procedures, and calibration procedures for each device.

e. An HVAC control system commissioning procedures equipment list that lists the equipment to be used to accomplish commissioning. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

Performance Verification Test Procedures; GA, RE.

Six copies of the HVAC control system performance verification test procedures, in indexed booklet form, 60 days before the Contractor's scheduled test dates. The performance verification test procedures shall refer to the devices by their unique identifiers as shown, shall explain, step-by-step, the actions and expected results that will demonstrate that the HVAC control system performs in accordance with the sequences of operation. An HVAC control system performance verification test equipment list shall be included that lists the equipment to be used during performance verification testing. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

Training Course Materials; GA, RE.

Six copies of HVAC control system training course material 30 days prior to the scheduled start of the training course. The training course material shall include the operation manual, maintenance and repair manual, and paper copies of overheads used in the course. An HVAC control system training course, in outline form, with a proposed time schedule. Approval of the planned training schedule shall be obtained from the Government at least 60 days prior to the start of the training.

SD-09 Reports

Commissioning Report; GA, RE.

Six copies of the HVAC control system commissioning report, in indexed booklet form, within 30 days after completion of the system commissioning. The commissioning report shall include data collected during the HVAC control system commissioning and shall follow the format of the commissioning procedures. The commissioning report shall include all controller and time clock check sheets with final values listed for all parameters, setpoints, P, I, D setting constants, calibration data for all devices, and results of adjustments.

Performance Verification Test Report; GA, RE.

Six copies of the HVAC control system performance verification test report, in indexed booklet form, within 30 days after completion of the test. The HVAC control system performance verification test report shall include data collected during the HVAC control system performance verification test. The original copies of data gathered during the performance verification test shall be turned over to the Government after Government approval of the test results.

SD-18 Records

Service Organizations; GA, RE.

Six copies of a list of service organizations qualified to service the HVAC control system. The list shall include the service organization name, address, technical point of contact and telephone number, and contractual point of contact and telephone number.

SD-19 Operation and Maintenance Manuals

Operation Manual; GA, ED.

Maintenance and Repair Manual; GA, ED.

Six copies of the HVAC control system operation manual and HVAC control system maintenance and repair manual for each HVAC control system 30 days before the date scheduled for the training course.

1.5 DELIVERY AND STORAGE

Products shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage-condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

1.6 OPERATION MANUAL

An HVAC control system operation manual for each HVAC control system, in indexed booklet form, shall be provided. The operation manual shall include the HVAC control system sequence of operation, and procedures for the HVAC system start-up, operation and shut-down. The operation manual shall include as-built HVAC control system detail drawings. The operation manual shall include the as-built the as-built the HVAC control system the procedures for gaining manual control of processes.

1.7 MAINTENANCE AND REPAIR MANUAL

An HVAC control system maintenance and repair manual for each HVAC control system, in indexed booklet form in hardback binders, shall be provided. The maintenance and repair manual shall include the routine maintenance checklist, a recommended repair methods list, a list of recommended maintenance and repair tools, the qualified service organization list, the as-built commissioning procedures and report, the as-built performance verification test procedures and report, and the as-built equipment data booklet (EDB).

a. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all devices listed in the equipment compliance booklet (ECB), the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.

b. The recommended repair methods list shall be arranged in a columnar format and shall list all devices in the equipment compliance booklet (ECB) and state the guidance on recommended repair methods, either field repair, factory repair, or whole-item replacement.

c. The as-built equipment data booklet (EDB) shall include the equipment compliance booklet (ECB) and all manufacturer supplied user manuals and information.

d. If the operation manual and the maintenance and repair manual are provided in a common volume, they shall be clearly differentiated and separately indexed.

PART 2 PRODUCTS

2.1 MATERIAL AND EQUIPMENT

Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to submitting for approval. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. The Contractor shall submit a certified list of qualified permanent service organizations and qualifications. These service organizations shall be reasonably convenient to the equipment on a regular and emergency basis during the warranty period.

2.2 GENERAL EQUIPMENT REQUIREMENTS

2.2.1 Electrical and Electronic Devices

All electrical, electronic, and electro-pneumatic devices not located within an HVAC control panel shall have a NEMA Type 1 enclosure in accordance with NEMA 250 unless otherwise shown.

2.2.2 Ambient Temperature Limits

Ambient Temperature Actuators shall operate within temperature limit ratings of 40 to 140 degrees F. except those actuators to be installed in the airstream of the remote radiator. actuators operating in the airstream of the remote radiator shall operate within temperature limit ratings of 50 to 220 degrees F. All panel-mounted and wall mounted controls and instruments shall operate within limit ratings of 35 to 120 degrees F and 10 percent to 95 percent relative humidity, noncondensing.

2.2.3 Nameplates, Lens Caps, and Tag Nameplates

Nameplates, lens caps, and lens caps bearing legends as shown and tags bearing device-unique identifiers as shown shall have engraved or stamped characters. A plastic or metal tag shall be mechanically attached directly to each device or attached by a metal chain or wire. Each air flow measurement station shall have a tag showing flow rate range for signal output range, duct size, and identifier as shown.

2.2.4 Year 2000 Compliance

All equipment shall be Year 2000 compliant and shall be able to accurately process date/time data (including, but not limited to, calculating, comparing, and sequencing) from, into, and between the twentieth and twenty-first centuries, including leap year calculations, when used in accordance with the product documentation provided by the contractor, provided that all products (e.g. hardware, software, firmware) used in combination with other information technology, shall accurately process date/time data if other information technology properly exchanges date/time data with it.

2.3 MATERIALS

2.3.1 Wiring

2.3.1.1 Terminal Blocks

Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

2.3.1.2 Control Wiring for 24-Volt Circuits

Control wiring for 24-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 300-volt service.

2.3.1.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 600-volt service.

2.3.1.4 Transformers

Step-down transformers shall be utilized where control equipment operates at lower than line circuit voltage. Transformers shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage. Transformers shall be sized so that the connected load is 80 percent of the rated capacity or less. Transformers shall conform to UL 508.

2.4 ACTUATORS

Actuators shall be electric or electronic shall be provided with mounting and connecting hardware. Electric actuators shall be used all dampers. Actuators shall fail to their spring-return positions on signal or power failure. The actuator stroke shall be limited in the direction of power stroke by an adjustable stop. Actuators shall smoothly open or close the devices to which they are applied and shall have a full stroke response time of 90 seconds or less.

2.5 DAMPERS

2.5.1 Damper Assembly

A single damper section shall have blades no longer than 48 inches and shall be no higher than 72 inches. Maximum damper blade width shall be 8 inches. Larger sizes shall be made from a combination of sections. Dampers shall be galvanized steel. Flat blades shall be made rigid by folding the edges. All blade-operating linkages shall be within the frame so that blade-connecting devices within the same damper section will not be located directly in the air stream. Damper axles shall be 3/16 inch (minimum) plated steel rods supported in the damper frame by stainless steel, bronze, or acetal bearings. Blades mounted vertically shall be supported by thrust bearings. Pressure drop through dampers shall not exceed 0.4 inch water gauge at 1,500 fpm in the wide-open position. Frames shall not be less than 2 inches in width. Dampers shall be tested in accordance with AMCA 500-D.

2.5.1.1 Operating Links

Operating links external to dampers (such as crankarms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers) shall withstand a load equal to at least twice the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crankarms shall control the open and closed positions of dampers.

2.5.1.2 Damper Types

Dampers shall be parallel blade type.

2.5.2 Equipment Space Ventilation Dampers

The dampers shall be as shown. Dampers shall not leak in excess of 80 cfm per square foot at 4 inches water (gauge) static pressure when closed. Dampers shall be rated at not less than 2000 fpm air velocity.

2.5.3 Damper End Switches

Dampers shall have end switches. Each end switch shall be a hermetically-sealed switch with a trip lever and over-travel mechanism. The switch enclosure shall be suitable for mounting on the damper and shall permit setting the position of the trip lever that actuates the switch. The trip lever shall be aligned with the damper blade.

2.6 THERMOSTATS

Thermostat ranges shall be selected so that the setpoint is adjustable between plus or minus 10 degrees F of the setpoint shown. Thermostats shall be electronic or electric.

2.6.1 Microprocessor-Based Room Thermostats

Microprocessor-based thermostats shall have built-in keypads for scheduling of day and night temperature settings. When out of the scheduling mode, thermostats shall have continuous display of time, with AM and PM indicator, continuous display of day of week, and either continuous display of room temperature with display of temperature setpoint on demand, or continuous display of temperature setpoint with display of room temperature on demand. In the programmable mode, the display shall be used for interrogating time program ON-OFF setpoints for all 7 days of the week. The time program shall allow 2 separate temperature-setback intervals per day. The thermostats shall have a means for temporary and manual override of the program schedule, with automatic program restoration on the following day. Thermostats shall have a replaceable battery to maintain the timing and maintain the schedule in memory for 1 year in the event of a power outage. Thermostat shall provide two stage control for heating and cooling. Additionally thermostat shall will stage supplemental electric heat in periods of high demand. Maximum differential shall be 2 degrees F. The thermostat shall also have an "EMERGENCY HEAT" switch.

2.6.2 Duct Thermostats

Thermostats shall have a single-pole, double-throw (SPDT) switch hermetically sealed. Switch shall be rated for 120/240 VAC, 20 A @ 120 VAC and actuated by a bimetallic or liquid filled remote bulb type element. Remote bulb elements shall have capillary tube length of 8 to 10 feet. Thermostat shall be enclosed in a NEMA 1 enclosure. Thermostats shall be provided with an adjustable temperature range of 30 to 100 degrees F. The thermostat shall have a 5 degree F differential and an initial setpoint of 65 degrees F.

2.6.3 Equipment Space Thermostats

Thermostats shall have a single-pole, double-throw (SPDT) switch hermetically sealed. Switch shall be rated for 120/240 VAC, 20 A @ 120 VAC and actuated by a liquid filled remote bulb type element. Remote bulb elements shall have capillary tube length of 8 to 10 feet. Thermostat shall be enclosed in a NEMA 1 enclosure. Thermostats shall be provided with an adjustable temperature range of 40 to 140 degrees F. and a differential of 5 degrees F. Setpoint shall be 105 degrees F for ventilation fans and 50 degrees F for unit-heaters.

2.7 CONTROL DEVICES AND ACCESSORIES

2.7.1 Relays

Relays shall be single pole, double-throw (SPDT) rated at 120/240 VAC with a 20-ampere @ 120 VAC. Relay shall have an enclosed 120-VAC coil with 5 pin blade connectors.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION CRITERIA

The HVAC controls system shall be installed and ready for operation, as specified. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. The HVAC controls installation shall provide clearance for control system maintenance by maintaining access space required to calibrate, remove, repair, or replace control system devices. The control system installation shall not interfere with the clearance requirements for mechanical installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.1 Device Mounting Criteria

Devices mounted in or on ductwork, on building surfaces, in mechanical/electrical spaces, or in occupied spaces shall be installed in accordance with manufacturer's recommendations. Control devices to be installed in ductwork shall be provided with all required gaskets, flanges, thermal compounds, insulation and calibration.

3.1.2 Wiring Criteria

Wiring external to HVAC systems, including low-voltage wiring, shall be installed in metallic raceways. Wiring shall be installed without splices between control devices and HVAC systems. Cables and conductors shall be tagged at both ends, with the identifier shown on the shop drawings, in accordance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Other electrical work shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR and as shown.

3.2 CONTROL SYSTEM INSTALLATION

3.2.1 Damper Actuators

Multiple actuators operating a common damper shall be connected to a common drive shaft. Actuators shall be installed so that their action shall seal the damper to the extent required to maintain leakage at or below the specified rate and shall move the blades smoothly.

3.2.2 Thermostat Mounting

Room thermostats in occupied spaces, shall be mounted 5 feet above the floor in the locations shown unless otherwise noted.

Equipment space thermostats, shall be mounted in a location such that the sensing elements may be placed follows. Thermostats controlling the intake and exhaust dampers shall have the sensing element placed in the airstream of the exhaust air. Thermostats controlling unit-heaters shall have the sensing element placed in the entering airstream to the unit-heater.

Duct thermostats shall be installed such that the sensing element is in the entering air stream for the device it controls.

3.3 CONTROL SEQUENCES OF OPERATION

3.3.1 System Requirements

These requirements shall apply to all primary HVAC systems unless modified herein. The sequences describe the actions of the control system for one direction of change in the HVAC process analog variable, such as temperature, humidity or pressure. The reverse sequence shall occur when the direction of change is reversed.

3.3.2 Unit-Heater

An equipment space thermostat shall cycle the unit-heater to maintain its setpoint of 50 degrees F. When equipment space temperature falls to 5 degrees below the setpoint the unit-heater shall cycle on. The unit-heater shall operate until the equipment space temperature reaches the setpoint.

3.3.3 Heat Pump and Air Handler

A microprocessor-based room thermostat, located as shown, with "HEAT-OFF-COOL", "AUTO-ON" and "EMERGENCY HEAT" switches shall control the appropriate heat pump and air handling unit serving the space in which it is located. When the switch is in the "HEATING" position, the heat pump shall switch to heating mode and heating shall be active. The thermostat shall operate the heat pump, supplemental electric heat, and system fan to maintain the heating setpoint. When the switch is in the "COOLING" position, the heatpump shall be placed in cooling mode. The thermostat shall operate the heat pump and system fan to maintain the cooling setpoint. When the "AUTO-ON" switch is in the "ON" position, the system fan shall run continuously. In the "AUTO" position, the system fan shall operate whenever heating or coolingg is required. When in the "EMERGENCY HEAT" switch is engaged the system fan and the supplemental electric shall be active.

Specific to AHU-2 is the control of a pre-heat coil. A duct thermostat located in the entering airstream to PC-1 shall control the OFF-ON state of PC-1 when the system fan is operating. When the system fan is off PC-1 shall be off.

3.3.4 Ventilation Fan

When equipment space temperature rises to setpoint of 105 degrees F an equipment space thermostat shall engage to open interlocked intake and exhaust dampers. At the full open position the dampers shall close damper end switches, that are wired in series. The closing of damper end switches shall energize coils in motor starters thereby starting the fans interlocked with the dampers. The intake and exhaust dampers shall remain open until the equipment space temperature decreases to 5 degrees below the setpoint.

3.4 COMMISSIONING PROCEDURES

3.4.1 General Procedures

3.4.1.1 Evaluations

The Contractor shall make the observations, adjustments, calibrations, measurements, and tests of the control systems, and make any necessary control-system corrections to ensure that the systems function as described in paragraph CONTROL SEQUENCES OF OPERATION.

3.4.1.2 Item Check

An item-by-item check of the sequence of operation shall be performed using in the specified control system commissioning procedures. Signals used to change the mode of operation shall originate from the actual HVAC control device intended for the purpose. With each operational-mode change signal relay contacts, actuators, ect. shall be observed to ensure that they function.

3.4.1.3 Weather-Dependent Test Procedures

Weather-dependent test procedures that cannot be performed by simulation shall be performed in the appropriate climatic season. When simulation is used, the Contractor shall verify the actual results in the appropriate season.

3.4.2 Unit Heater

The "OFF/AUTO" switch shall be placed in the "OFF" position. Each space-thermostat temperature setting shall be turned up so that it makes contact to turn on the unit-heater fans. The unit-heater fans shall not start. The "OFF/AUTO" switch shall be placed in the "AUTO" position. The unit-heater fans shall start. Each space-thermostat temperature setting shall be turned down, and the unit-heater fans shall stop. The thermostats shall be set at their temperature setpoints shown. The results of testing of one of each type of unit shall be logged.

3.4.3 Building A AHU-1.

The fan "AUTO/ON" switch shall be set to "ON". The heating-cooling switch shall be raised to "HEATING" and cooling shall be off. The temperature setpoint shall be raised and heating shall start. The heating/cooling switch shall be set to "COOLING" and heat shall be off. The temperature setpoint shall be lowered and cooling shall start. The fan "AUTO/ON" switch shall be set to "AUTO" and the foregoing procedure repeated. The fan shall start and stop automatically with the starting and stopping of heating and cooling. The power to the thermostat shall be shut off and it shall be verified that the thermostat clock keeps time.

3.4.4 Building A AHU-2

With the fan not running it shall be verified restroom exhaust fans are also off. It shall also be verified that pre-heat coil (PC-1) cannot energized. Duct thermostat setpoint shall be raised, PC-1 should have zero current draw. The fan "AUTO/ON" switch shall be set to "ON". PC-1 should now function. Restroom exhaust fans should be functioning. Reset PC-1 duct thermostat to its normal setpoint. The heating-cooling switch shall be raised to "HEATING" and cooling shall be off. The temperature setpoint shall be raised and heating shall start. The heating/cooling switch shall be set to "COOLING" and heat shall be off. The temperature setpoint shall be lowered and cooling shall start. The fan "AUTO/ON" switch shall be set to "AUTO" and the foregoing procedure repeated. The fan and restroom exhaust fans shall start and stop automatically with the starting and stopping of heating and cooling. The power to the thermostat shall be shut off and it shall be verified that the thermostat clock keeps time.

3.4.5 Equipment Space Ventilation

Following is repeated in Buildings A, B, C, D. Each equipment space thermostat temperature setting shall be turned up so that it makes contact to energize damper actuators. Associated intake and exhaust dampers shall open. At full open of all dampers interlocked fans shall start. temperature setting shall be turned down so that thermostat breaks contact the dampers should start to close, fans should power down.

3.4.6 Generator Space Ventilation

***3*1**

Space thermostat **setpoint** shall be turned **down so that its contacts close, motor operated dampers MOD-1 and MOD-3 shall open. When MOD-1 is fully open exhaust fan EF-2 shall start. Electrical Generator shall be started. Motor operated dampers MOD-2 and MOD-4 shall open and MOD-1 shall close on generator start. When MOD-4 is fully open supply fan SF-1 shall start. As MOD-1 begins to close EF-2 shall power down. Exhaust fan EF-1 shall start as specified by the Electrical Generator Manufacturer to maintain proper cooling for the selected diesel engine. Supply fans SF-2 and SF-3 shall start when EF-1 starts. Setpoint on space thermostat shall be raised so that thermostat breaks contact, motor operated dampers MOD-2, MOD-3 and MOD-4 shall close, SF-1 shall power down. SF-2 and SF-3 shall continue to run as long as EF-1 is operating. When EF-1 stops, SF-2 and SF-3 shall stop. Setpoint shall be lowered until contacts make, MOD-2, MOD-3 and MOD-4 shall open. SF-1 shall start. Generator shall be stopped MOD-2 and MOD-4 shall close and MOD-1 shall open. SF-1 shall power down as MOD-4 closes. EF-2 shall start when MOD-1 is fully open. Thermostat setpoint shall be raised until contacts break. MOD-1 and MOD-3 shall close. EF-2 shall stop as MOD-1 closes.**

***1*3**

3.5 BALANCING, COMMISSIONING, AND TESTING

3.5.1 Coordination with HVAC System Balancing

Commissioning of the control system, prior to or simultaneous with HVAC system balancing.

3.5.2 Control System Calibration, Adjustments, and Commissioning

Control system commissioning shall be performed for each HVAC system, using test plans and procedures previously approved by the Government. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform commissioning and testing of the HVAC control system. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Wiring shall be tested for continuity and for ground, open, and short circuits. Mechanical control devices shall be adjusted to operate as specified. Written notification of any planned commissioning or testing of the HVAC control systems shall be given to the Government at least 14 calendar days in advance.

3.5.3 Performance Verification Test

The Contractor shall demonstrate compliance of the HVAC control system with the contract documents. Using test plans and procedures previously approved by the Government, the Contractor shall demonstrate all physical and functional requirements of the project. The performance verification test shall show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. The performance verification test shall not be started until after receipt by the Contractor of written permission by the Government, based on Government approval of the commissioning report and completion of balancing.

3.5.4 Posted and Panel Instructions

Posted and panel instructions, showing the final installed conditions, shall be provided for each system. The posted instructions shall consist of half size laminated drawings and shall include the control system schematic, equipment schedule, ladder diagram, sequence of operation, wiring diagram, and damper schedules. The posted instructions shall be permanently affixed, by mechanical means, to a wall designated by the Contracting Officer.

3.6 TRAINING

3.6.1 Training-Course Requirements

A training course shall be conducted for operating staff members designated by the Contracting Officer. The training period, for a total of 12 hours of normal working time, shall be conducted within 30 days after successful completion of the performance verification test. The training course shall be conducted at the project site. Audiovisual equipment and all other training materials and supplies shall be provided. A training day is defined as 8 hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

3.6.2 Training-Course Content

For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are not familiar with HVAC systems. The training course shall cover all of the material contained in the operating and maintenance instructions, the layout and location of each HVAC control system, the layout of one of each type of unitary equipment and the locations of each, the location of each system-control device external to HVAC equipment preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, and repair procedures.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15995

COMMISSIONING OF HVAC SYSTEMS

01/93

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SECTION 15995

COMMISSIONING OF HVAC SYSTEMS
01/93

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Data

Commissioning Team; FIO

List of team members who will represent the Contractor in the pre-commissioning checks and functional performance testing, at least 2 weeks prior to the start of pre-commissioning checks. Proposed revision to the list, prior to the start of the impacted work.

SD-06 Instructions

Test Procedures; GA, RE.

Detailed procedures for pre-commissioning checks and functional performance tests, at least 4 weeks prior to the start of pre-commissioning checks.

SD-07 Schedules

Test Schedule; GA, RE.

Schedule for pre-commissioning checks and functional performance tests, at least 2 weeks prior to the start of pre-commissioning checks.

SD-09 Reports

Test Reports; GA, ED.

Completed pre-commissioning checklists and functional performance test checklists organized by system and by subsystem and submitted as one package. The results of failed tests shall be included along with a description of the corrective action taken.

1.2 PAYMENT

No seperate payment shall be made items and work contained in this specification. Payment shall be incidental to bid item CONTROL BUILDINGS

1.3 SEQUENCING AND SCHEDULING

The work described in this Section shall begin only after all work required in related Sections, including Section 15950 HEATING, VENTILATING, AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS and Section 15990 TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS, has been successfully completed, and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved. Seismic details shall be in accordance with Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 COMMISSIONING TEAM AND CHECKLISTS

The Contractor shall designate team members to participate in the pre-commissioning checks and the functional performance testing specified herein. In addition, the Government will be represented by a representative of the Contracting Officer, the Design Agent's Representative, and the Using Agency. The team members shall be as follows:

Designation	Function
Q	Contractor's Chief Quality Control Representative
M	Contractor's Mechanical Representative
E	Contractor's Electrical Representative
T	Contractor's Testing, Adjusting, and Balancing Representative
C	Contractor's Controls Representative
D	Design Agent's Representative
O	Contracting Officer's Representative
U	Using Agency's Representative

Each checklist shown in appendices A and B shall be completed by the commissioning team. Acceptance by each commissioning team member of each pre-commissioning checklist item shall be indicated by initials and date unless an "X" is shown indicating that participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test checklist shall be indicated by signature and date.

3.2 TESTS

The pre-commissioning checks and functional performance tests shall be performed in a manner which essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, methods shall be established which will provide the information required. Testing and verification required by this section shall be performed during the Commissioning phase. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section. The Contractor shall provide all materials, services, and labor required to perform the pre-commissioning checks and functional performance tests. A pre-commissioning check or functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test. The Contractor shall reimburse the Government for all costs associated with effort lost due to tests that are aborted. These costs shall include salary, travel costs and per diem (where applicable) for Government commissioning team members.

3.2.1 Pre-Commissioning Checks

Pre-commissioning checks shall be performed for the items indicated on the checklists in Appendix A. Deficiencies discovered during these checks shall be corrected and retested in accordance with the applicable contract requirements.

3.2.2 Functional Performance Tests

Functional performance tests shall be performed for the items indicated on the checklists in Appendix B. Functional performance tests shall begin only after all pre-commissioning checks have been successfully completed. Tests shall prove all modes of the sequences of operation, and shall verify all other relevant contract requirements. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. The checklist shall then be repeated until it has been completed with no errors.

APPENDIX A

PRE-COMMISSIONING CHECKLISTS

Pre-commissioning Checklist - Ductwork

For Air Handler, Intake Fan and Exhaust Fan: All

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Ductwork complete.	___	___	X	___	X	___	___	___
b. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
c. Ductwork leak test complete.	___	___	X	___	X	___	___	___

NOTE: The first bracketed item d will be used for Army projects, the second for Air Force projects.

Checklist Item	Q	M	E	T	C	D	O	U
d. Fire dampers, smoke dampers, and access doors installed as required.	___	___	X	___	X	___	___	___
e. Ductwork insulated as required.	___	___	X	___	X	___	___	___
f. Verify open/closed status of dampers.	___	___	X	___	X	___	___	___
g. Flexible connectors installed as specified	__	___	X	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB operation complete.	___	___	X	___	X	___	___	___

Pre-commissioning Checklist - Heat Pump

For Condensing Unit: All

Checklist Item	Q	M	E	T	C	D	O	U
Installation	___	___	X	X	X	___	___	___
b. Refrigerant pipe leak tested.	___	___	X	X	X	___	___	___
c. Refrigerant pipe evacuated and charged in accordance with manufacturer's instructions.	___	___	X	X	X	___	___	___
d. Check condenser fans for proper rotation.	___	___	X	___	X	___	___	___
e. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
f. Manufacturer's required maintenance/ operational clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	X	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls	___	___	___	X	___	___	___	___
Controls								
a. Unit safety/protection devices tested.	___	___	X	X	___	___	___	___
b. Control system and interlocks installed.	___	___	X	X	___	___	___	___
c. Control system and interlocks operational.	___	___	X	X	___	___	___	___

Pre-commissioning Checklist - Unit Heater

For Unit Heater: All

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Manufacturer's required maintenance/ operational clearance provided.			X	X	X			
Electrical								
a. Power available to unit disconnect.				X				
b. Proper motor rotation verified.				X	X			
c. Verify that power disconnect is located within sight of the unit it controls.				X				
d. Power available to electric heating coil.				X				
Controls								
a. Controls properly installed.			X					
b. Verify proper location and installation of thermostat.			X					
Testing, Adjusting, and Balancing (TAB)								
a. TAB Report submitted.			X		X			

Pre-commissioning Checklist - Exhaust and Intake Fan

For Exhaust and Intake Fan: All

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Fan belt adjusted if applicable.	___	___	X	___	X	___	___	___
Electrical								
a. Power available to fan disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
Controls								
a. Control interlocks properly installed.	___	___	___	X	___	___	___	___
b. Control interlocks operable.	___	___	___	X	___	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___	___	___
e. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___
Testing, Adjusting, and Balancing (TAB)								
a. TAB results +10%/-0% to cfm shown on drawings	___	___	X	___	X	___	___	___
b. TAB Report submitted.	___	___	X	___	X	___	___	___

***3**
Pre-commissioning Checklist - HVAC System Controls

For HVAC System: **All**

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. As-built shop drawings submitted.	___	___	X	X	___	___	___	___
b. Framed instructions mounted in or near control panel.	___	___	X	X	___	___	___	___
c. Components properly labeled.	___	___	X	X	___	___	___	___
d. Control components wired to each labeled terminal strip.	___	___	X	X	___	___	___	___
e. **Control wiring labeled at all terminations, splices, and junctions.**	___	___	X	X	___	___	___	___
h. **N/A**	__	__	X	X	___	___	___	___
Main Power								
a. **24/110/208 volt AC power available.**	___	___	___	X	___	___	___	___
Testing, Commissioning, and Balancing								
a. Testing, Commissioning, and Balancing Report submitted.	___	___	X	___	___	___	___	___

***3**

Pre-commissioning Checklist - Air Handling Unit

For Air Handling Unit: All

Checklist Item	Q	M	E	T	C	D	O	U
Installation								
a. Vibration isolation devices installed.			X	X	X			
b. Inspection and access doors are operable and sealed.			X		X			
c. Casing undamaged.			X	X	X			
d. Insulation undamaged.			X	X	X			
e. Condensate drainage is unobstructed.			X	X	X			
f. Fan belt adjusted, if applicable.			X		X			
g. Any damage to coil fins has been repaired.			X		X			
h. Manufacturer's required maintenance clearance provided.			X	X	X			
Electrical								
a. Power available to unit disconnect.				X	X			
b. Power available to unit control panel.				X				
c. Proper motor rotation verified.					X			
d. Verify that power disconnect is located within sight of the unit it controls.				X				
e. Power available to electric heating coils.				X				
Coils								
a. Refrigerant piping properly connected.			X	X	X			
b. Refrigerant piping pressure tested.			X	X	X			
c. Any damage to coil fins has been repaired.			X		X			
Controls								
a. Control properly installed.			X					
b. Control operable.			X					

Pre-commissioning Checklist - Air Handling Unit

For Air Handling Unit: All

Checklist Item	Q	M	E	T	C	D	O	U
e. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___

Testing, Adjusting, and Balancing (TAB)

	Q	M	E	T	C	D	O	U
a. Construction filters removed and replaced.	___	___	X	___	X	___	___	___
b. TAB results +10%/-0% cfm shown on drawings.	___	___	X	___	X	___	___	___
c. TAB Report submitted.	___	___	X	___	X	___	___	___

APPENDIX B

FUNCTIONAL PERFORMANCE TESTS CHECKLISTS

Functional Performance Test Checklist - Air Handling Unit

For Air Handling Unit: All

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:
***3**

a. The following shall be verified when the AUTO-ON fan operating mode is switched to ON:

(1) System safeties allow start if safety conditions are met. _____

(2) Power is available to Preheat coil (PC-1),applicable to AHU-2 only. ____

(3) Exhuast fan EF-1, applicable to AHU-2 only. ____________________

b. Cooling mode of operation, room temperature is above setpoint.

(1) Supply fan starts. ____

(2) Heat pump starts in cooling mode. ____________________________

(3) Preheat coil PC-1 is not energized. Applicable to AHU-2 only. ____

c. Heating mode of operation, room temperature is below setpoint.

(1) Supply fan starts. ____

(2) Heat pump starts in heating mode. ____________________________

(3) Preheat coil PC-1 is energized when mixed air in return duct is below the setpoint of return duct thermostat. Else PC-1 is not energized. Applicable to AHU-2 only. _____________________

d. Emergency heating mode, room temperature is below setpoint.

(1) Supply fan starts. ____

(2) Heat pump is stopped. ____

(3) Supplimental electric heaters are energized. _________________

(4) Preheat coil PC-1 is energized when mixed air in return duct is below the setpoint of return duct thermostat. Else PC-1 is not energized. Applicable to AHU-2 only. _____________________

e. The following shall be verified when the AUTO-ON fan operating mode is switch to AUTO. Emergency heating mode is initiated, room temperature is above setpoint.

(1) Supplimental electric heaters are de-energized.______________

(2) Supply fan stops. ____________________

(3) Preheat coil PC-1 is de-energized. Applicable to AHU-2 only. ____________________

(4) Heat pump is off. ____________________

***3**

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

	Signature and Date
Contractor's Chief Quality Control Representative	____________________
Contractor's Mechanical Representative	____________________
Contractor's Electrical Representative	____________________
Contractor's Testing, Adjusting and Balancing Representative	____________________
Contractor's Controls Representative	____________________
Contracting Officer's Representative	____________________
Using Agency's Representative	____________________

Functional Performance Test Checklist - Heat Pump

For Condensing Unit: All

1. Functional Performance Test: Contractor shall demonstrate operation of refrigeration system as per specifications including the following: Start building air handler to provide load for condensing unit. Activate controls system start sequence as follows.

a. Start air handling unit. Verify control system energizes condensing unit start sequence. ______________________________

b. Shut off air handling equipment to verify condensing unit de-energizes. ______________________________

c. Restart air handling equipment one minute after condensing unit shutdown. Verify condensing unit restart sequence. ______________________________

2. Verify condensing unit amperage each phase and voltage phase to phase and phase to ground.

	PHASE 1	PHASE 2	PHASE 3
Amperage	________	________	________
Voltage	________	________	
Voltage	________________		
Voltage to ground	________	________	________

3. Record the following information:

Ambient dry bulb temperature	________	degrees F
Ambient wet bulb temperature	________	degrees F
Suction pressure	________	psig
Discharge pressure	________	psig

4. Unusual vibration, noise, etc.

____

____

5. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Chief Quality Control Representative ______________________________

Contractor's Mechanical Representative ______________________________

Contractor's Electrical Representative Representative ______________________________

Contractor's Testing, Adjusting and Balancing ______________________________

Functional Performance Test Checklist - Heat Pump

For Condensing Unit: All

Contractor's Controls Representative ______________________________

Contracting Officer's Representative ______________________________

Using Agency's Representative ______________________________

***3**
Functional Performance Test Checklist - Unit Heaters

1. Functional Performance Test: Contractor shall demonstrate operation of unit heaters as per specifications including the following:

a. Verify unit heater response to room temperature set point adjustment. Change the heating set point to heating set point minus 5 degrees and return to heating set point. ________________________________
***3**

b. Check blower fan speed. ____________________________________rpm

c. Check heating mode inlet air temperature. Check heating mode inlet air temperature. _____ degrees F

d. Check heating mode outlet air temperature. Check heating mode outlet air temperature. _____ degrees F

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

	Signature and Date
Contractor's Chief Quality Control Representative	____________________________
Contractor's Mechanical Representative	____________________________
Contractor's Electrical Representative	____________________________
Contractor's Testing, Adjusting and Balancing Representative	____________________________
Contractor's Controls Representative	____________________________
Contracting Officer's Representative	____________________________
Using Agency's Representative	____________________________

Functional Performance Test Checklist - HVAC Controls

For HVAC System: All

***3**

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the following tests:

a. Verify proper operation of the individual control systems by following the commissioning procedures in Section 15950.

b. Verify that controller is maintaining the set point by manually measuring the controlled variable with a thermometer, sling psychrometer, inclined manometer, etc.

Controller ____

Manual measurement ________________________________

Set Point value ________________________________

c. Verify system stability by changing the controller set point as follows:

(1) Air temperature - 10 degrees F

The control system shall be observed for 10 minutes after the change in set point. Instability or excessive hunting will be unacceptable.

d. Verify interlock with other HVAC controls.

2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

***3**

Signature and Date

Contractor's Chief Quality Control Representative ___________________________

Contractor's Mechanical Representative ___________________________

Contractor's Electrical Representative ___________________________

Contractor's Testing, Adjusting and Balancing Representative

____

Contractor's Controls Representative ___________________________

Contractor's Officer's Representative ___________________________

Using Agency's Representative ___________________________

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16263

DIESEL-GENERATOR SET STATIONARY, WITH AUXILIARIES

04/99

-- End of Section Table of Contents --

SECTION 16263

DIESEL-GENERATOR SET STATIONARY, WITH AUXILIARIES
04/99

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.11	(1987; R 1993) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)
ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 106	(1999) Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 181/A 181M	(2001) Carbon Steel Forgings for General-Purpose Piping
ASTM A 234/A 234M	(2001a) Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperatures
ASTM D 975	(1994) Diesel Fuel Oils

ASME INTERNATONAL (ASME)

ASME B16.3	(1999) Malleable Iron Threaded Fittings
ASME B16.5	(1996; B16.5a) Pipe Flanges and Flanged Fittings NPS 1/2 thru NPS 24
ASME B16.11	(1996) Forged Fittings, Socket-Welding and Threaded
ASME B31.1	(2001) Power Piping
ASME BPV IX	(1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing

Qualifications

ELECTRICAL GENERATING SYSTEMS ASSOCIATION (EGSA)

EGSA 101P	(1995a) Engine Driven Generator Sets

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE ANSI/IEEE C57.13.1	(1981; R 1992) IEEE Guide for Field Testing of Relaying Current Transformers
IEEE Std 1	(1986; R 2000) General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation
IEEE Std 43	(1974; R 2000) Testing Insulation Resistance of Rotating Machinery
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
IEEE Std 100	(1996) IEEE Standard Dictionary of Electrical and Electronics Terms
IEEE Std 120	(1989) Electrical Measurements in Power Circuits
IEEE Std 115	(1995) Test Procedures for Synchronous Machines
IEEE Std 519	(1992) Harmonic Control in Electrical Power systems

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000) Industrial Control and Systems Controllers, Contactors, and Overload

	Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures
NEMA MG 1	(1998; Rev 1; Rev 2; Rev 3 Rev 4) Motors and Generators
NEMA PB 1	(1997) Panelboards
NEMA PB 2	(1995) Deadfront Distribution Switchboards
NEMA SG 5	(1995) Power Switchgear Assemblies

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2000; Errata; TIA 96-2) Flammable and Combustible Liquids Code
NFPA 37	(1998) Installation and Use of Stationary Combustion Engines and Gas Turbines
NFPA 70	(2002) National Electrical Code
NFPA 99	(1999) Health Care Facilities
NFPA 110	(1996) Emergency and Standby Power Systems

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J 537	(2000) Storage Batteries

UNDERWRITERS LABORATORIES (UL)

UL 142	(1993) Steel Aboveground Tanks for Flammable and Combustible Liquids
UL 508	(1999) Industrial Control Equipment
UL 1236	(1994; Rev thru Dec 1999) Battery Chargers for Charging Engine-Starter Batteries

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment and Performance; GA, ED.

Calculations of the engine and generator output power capability, including efficiency and parasitic load data.

Sound Power Level; GA, ED.

Sound power level data for the packaged unit operating at 100% load in a free field environment. The data should demonstrate compliance with the sound limitation requirements of this specification.

Harmonic and Non-linear Load Capability; FIO.

Description of the generator features which mitigate the effects of the non-linear loads listed.

Day Tank ; GA, ED.

Product data for the day tank shall include product features, capacity, specification and required listing.

Power Factor Capability Curve; FIO.

The generator capability curve showing generator kVA output capability (kW vs. kvar) for both leading and lagging power factors ranging from 0 to 1.0.

Heat Rejected To Engine-Generator Space; GA, ED.

Manufacturers data to quantify heat rejected to the space with the engine generator set at rated capacity shall be sumbitted before installation of ventilation equipment.

Cooling Equipment and Performance; GA, ED.

A letter which certifies that the engine-generator set and cooling system function properly in the ambient temperature specified.

a. The maximum allowable inlet temperature of the coolant fluid.

b. The minimum allowable inlet temperature of the coolant fluid.

c. The maximum allowable temperature rise in the coolant fluid through the engine.

Alarm Set Points; GA, ED.

The magnitude of monitored values which define alarm or action set points, and the tolerance (plus and/or minus) at which the devices activate the alarm or action for items contained within the alarm panels.

Generator Data; GA, ED.

Manufacturer's standard data for each generator (prototype data at the specified rating or above is acceptable)listing the following information:

Direct-Axis subtransient reactance (per unit).

The generator kW rating and short circuit current capacity (both symmetric and asymmetric)

Manufacturer's Catalog; GA, ED.

Manufacturer's standard catalog data describing and depicting each engine-generator set and all ancillary equipment in sufficient detail to demonstrate complete specification compliance.

Site Welding; FIO.

A copy of qualifying procedures and a list of names and identification symbols of qualified welders and welding operators.

Spare Parts; FIO.

A complete list of spare parts for each piece of equipment and a complete list of all material and supplies needed for continued operation. Lists shall include supply source and current prices. Each list shall be separated into two parts: those elements recommended by the manufacturer to be replaced after 3 years of service and the remaining elements.

Training; GA, RE.

A letter giving the date proposed for conducting the onsite training course, the agenda of instruction, a description of the video taping service to be provided, and the kind and quality of the tape to be left with the Contracting Officer at the end of the instructional period.

Battery Charger; GA, ED.

Battery charger sizing calculations.

Vibration-Isolation; FIO.

Vibration isolation system performance data for the range of frequencies generated by the engine-generator set during operation from no load to full load and the maximum vibration transmitted to the floor. Description of seismic qualification of the engine-generator mounting, base, and vibration isolation.

SD-04 Drawings

Layout and Shop Drawings; GA, ED.

Drawings shall include the following:

a. Base-mounted equipment, complete with base and attachments, including anchor bolt template and recommended clearances for maintenance and operation.

b. Complete starting system.

c. Complete fuel system.

d. Complete cooling system.

e. Complete exhaust system.

f. Layout of relays, breakers, programmable controllers,switchgear, and switches including applicable single line and wiring diagrams with written description of sequence of operation and the instrumentation provided.

g. The complete lubrication system, including piping, pumps, strainers, filters, heat exchangers for lube oil, and turbocharger cooling controls and wiring.

h. Location, type, and description of vibration isolation devices for all applications.

i. The safety system, together with a detailed description of how it is to work. Wiring schematics, safety devices with a listing of their normal ranges, andalarm and shutdown values (to include operation parameters such as pressures, temperatures voltages, currents, and speeds) shall be included.

j. One-line schematic and wiring diagrams of the generator, exciter, regulator, governor, and instrumentation.

k. Layout of each panel.

l. Mounting and support for each panel and major piece of electrical equipment.

m. Engine-generator set lifting points and rigging instructions.

As-Built Drawings; GA, RE.

Drawings which accurately depict the as-built configuration of the installation, upon acceptance of the diesel-generator set installation. Layout drawings shall be revised to reflect the as-built conditions and shall be submitted with the as-built drawings.

SD-06 Instructions

Posted Data; GA, RE.

Posted data including wiring and control diagrams showing the key mechanical and electrical control elements and a complete layout of the entire system.

Instructions; GA, ED.

Instructions including: the manufacturers pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Instructions shall include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches). Instructions shall be weatherproof, laminated in plastic, and posted where directed.

SD-08 Statements

Component Manufacturer; GA, RE.

Each component manufacturer has a minimum of 3 years experience in the manufacture, assembly, and sale of components used with stationary diesel engine-generator sets for commercial and industrial use.

Manufacturer/Assembler; GA, RE.

The engine-generator set manufacturer/assembler has a minimum of 3 years experience in the manufacture, assembly, and sale of stationary diesel engine-generator sets for commercial and industrial use.

Cooling System; GA, ED.

Certification that the engine-generator set and cooling system function properly in the ambient temperatures specified.

Field Engineer; GA, RE.

A letter listing the qualifications, schools, formal training, and experience of the field engineer.

Welder Qualification; GA, RE.

A letter listing the welder qualifying procedures for each welder, complete with supporting data such as test procedures used, what was tested to, and a list of the names of all welders and their identification symbols.

Installation Procedures; GA, ED.

A copy of the manufacturer's installation procedures and a detailed description of the manufacturer's recommended break-in procedure.

SD-09 Reports

Factory Inspection and Tests; GA, ED.

Six Complete reproducible copies of the factory inspection result on the checklist format specified in paragraph FACTORY INSPECTION AND TESTS.

Factory Tests; GA, RE.

a. A letter giving notice of the proposed dates of factory inspections and tests at least 14 days prior to beginning tests.

b. A detailed description of the manufacturer's procedures for factory tests at least 14 days prior to beginning tests.

c. Six copies of the Factory Test data described below in 8-1/2 x 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs. Data plots shall be full size (8-1/2 x 11 inch minimum), showing grid lines, with full resolution.

(1) A detailed description of the procedures for factory tests.

(2) A list of equipment used, with calibration certifications.

(3) A copy of measurements taken, with required plots and graphs.

(4) The date of testing.

(5) A list of the parameters verified.

(6) The condition specified for the parameter.

(7) The test results, signed and dated.

(8) A description of adjustments made.

On Site Tests; GA, RE.

a. A letter giving notice of the proposed dates of onsite inspections and tests at least 14 days prior to beginning tests.

b. A detailed description of the Contractor's procedures for onsite tests including the test plan and a listing of equipment necessary to perform the tests. Submission shall be at least 10 days prior to beginning tests.

c. Six copies of the onsite test data described below in 8-1/2 x 11 inch binders having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs. Data plots shall be full size (8-1/2 x 11 inch minimum), showing grid lines, with full resolution.

(1) A detailed description of the procedures for onsite tests.

(2) A list of equipment used, with calibration certifications.

(3) A copy of measurements taken, with required plots and graphs.

(4) The date of testing.

(5) A list of the parameters verified.

(6) The condition specified for the parameter.

(7) The test results, signed and dated.

(8) A description of adjustments made.

SD-13 Certificates

Torsional Vibration; GA, ED.

Torsional analysis including prototype testing or and calculations which certify and demonstrate that no damaging or dangerous torsional vibrations will occur when the prime mover is connected to the generator, at synchronous speeds, ± 10%.

Prototype Tests; FIO.

Manufacturer's standard certification that prototype tests were performed for the generator model proposed.

Reliability and Durability; GA, ED.

A reliability and durability certification letter from the manufacturer and assembler to prove that existing facilities are and have been successfully utilizing the same components proposed to meet this specification in similar service. Certification may be based on components, i.e. engines used with different models of generators and generators used with different engines, and does not exclude annual technological improvements made by a manufacturer in the basic standard-model component on which experience was obtained, provided parts interchangeability has not been substantially affected and the current standard model meets the performance requirements specified. Provide a list with the name of the installations, completion dates, and name and telephone number of a point of contact.

Emissions; FIO.

A certification from the engine manufacturer stating that the engine exhaust emissions meet the federal, state, and local regulations and restrictions specified. At a minimum this certification shall include emission factors for criteria pollutants including nitrogen oxides, carbon monoxide, particulate matter, sulfur dioxide, non-methane hydrocarbon, and for hazardous air pollutants (HPAs).

Sound Limitation; FIO

A certification from the manufacturer stating that the sound emissions meet the specification.

Site Visit; FIO.

A letter stating the date the site was visited and listing discrepancies found.

Flywheel Balance; GA, ED.

A certification stating that the flywheel has been statically and dynamically balanced and is capable of being rotated at 125% of rated speed without vibration or damage.

Standards Compliance; GA, RE.

A certification stating that where materials or equipment are specified to comply with requirements of UL, written proof of such compliance has been obtained. The label or listing of the specified agency, or a written certificate from an approved, nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of the specified agency are acceptable as proof.

Functional Facilities; GA, RE.

A letter certifying that all facilities are complete and functional; that each system is fully functional; and that each item of equipment is complete, free from damage, adjusted, and ready for beneficial use.

SD-19 Operation and Maintenance Manuals

Operation Manual; GA, ED.

Six copies of the operation manual (approved prior to commencing onsite tests) in 8-1/2 x 11 inch binders, having a minimum of 3 rings from which material may readily be removed and replaced, including a separate section for each system or subsystem. Sections shall be separated by heavy plastic dividers with tabs which identify the material in the section. Drawings shall be folded blue lines, with the title block visible, and placed in 8-1/2 x 11 inch plastic pockets with reinforced holes. One full size reproducible mylar of each drawing shall accompany the booklets. Mylars shall be rolled and placed in a heavy cardboard tube with threaded caps on each end. The manual shall include: step-by-step procedures for system startup, operation, and shutdown; drawings, diagrams, and single-line schematics to illustrate and define the electrical, mechanical, and hydraulic systems together with their controls, alarms, and safety systems andthe manufacturer's name, model number, and a description of equipment in the system. The instructions shall include procedures for interface and interaction with related systems to include automatic transfer switches . Each booklet shall include a CDROM containing an ASCII file of the procedures.

Maintenance Manual; GA, ED.

Six copies of the maintenance manual containing the information described below in 8-1/2 x 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each item listed. Each section shall be separated by a heavy plastic divider with tabs. Drawings shall be folded, with the title block visible, and placed in plastic pockets with reinforced holes.

a. Procedures for each routine maintenance item.

Procedures for troubleshooting.

Factory-service, take-down overhaul, and repair service manuals, with parts lists.

b. A copy of the posted instructions.

c. A component list which includes the manufacturer's name, address, type or style, model or serial number, rating, and catalog number for the major components specified for nameplates.

Six complete reproducible copies of the final relay and protective device settings. The settings shall be recorded with the name of the company and individual responsible for their accuracy.

Special Tools; GA, ED.

Two complete sets of special tools required for maintenance (except for electronic governor handset). Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. The tools shall be supplied complete with a suitable tool box. One handset shall be provided for each electronic governor when required to indicate and/or change governor response settings.

Filters; GA, RE

Two complete sets of filters shall be supplied in a suitable storage box. These filters shall be in addition to filters replaced after testing.

1.3 SYSTEM DESCRIPTION

Each engine-generator set shall be provided and installed complete and totally functional, with all necessary ancillary equipment to include: air filtration; starting system; generator controls, protection, and isolation; instrumentation; lubrication; fuel system; cooling system; and engine exhaust system. Each engine-generator set shall satisfy the requirements specified in the Engine-Generator Parameter Schedule.

1.3.1 Engine-Generator Parameter Schedule

ENGINE-GENERATOR PARAMETER SCHEDULE

Power Rating	Emergency Standby
Overload Capacity (Prime applications only)	110% of Service Load for 1 hour in 12 consecutive hours
Service Load	450 kVA (maximum)
Motor Starting kVA (Max.)	1350 kVA
Power Factor	0.8 lagging
Engine-Generator Applications	stand-alone

ENGINE-GENERATOR PARAMETER SCHEDULE

Maximum Speed	1800 rpm
Heat Exchanger Type	remote radiator shell-tube
Governor Type	Isochronous
Frequency Bandwidth (steady state)	$\pm$0.25%
Voltage Regulation (No Load to Full Load) (Stand alone applications)	$\pm$2% (maximum)
Voltage Bandwidth (steady state)	$\pm$2%
Frequency	60 Hz
Voltage	480/277 volts
Phases	3 Phase, Wye
Max Step Load Increase	25% of Service Load
Transient Recovery Time with Step Load Increase (Voltage)	6 seconds
Transient Recovery Time with Step Load Increase (Frequency)	6 seconds
Maximum Voltage Deviation with Step Load Increase	10 % of rated voltage
Maximum Frequency Deviation with Step Load Increase	5% of rated frequency
Max Step Load Decrease (without shutdown)	100% of Service Load
Max Time to Start and be Ready to Assume Load	8 seconds
Max Summer Outdoor Temp (Ambient)	105 degrees
Min Winter Outdoor Temp (Ambient)	5 degrees

ENGINE-GENERATOR PARAMETER SCHEDULE

Installation Elevation 443 ft. above sea level

1.3.2 Rated Output Capacity

Each engine-generator-set shall provide power equal to the sum of Service Load plus the machine's efficiency loss and associated ancillary equipment loads. Rated output capacity shall also consider engine and/or generator oversizing required to meet requirements in paragraph Engine-Generator Parameter Schedule.

1.3.3 Power Ratings

Power ratings shall be in accordance with EGSA 101P.

1.3.4 Transient Response

The engine-generator set governor and voltage regulator shall cause the engine-generator set to respond to the maximum step load changes such that output voltage and frequency recover to and stabilize within the operational bandwidth within the transient recovery time. The engine-generator set shall respond to maximum step load changes such that the maximum voltage and frequency deviations from bandwidth are not exceeded.

1.2.5 Reliability and Durability

Each standby engine-generator set shall have both an engine and a generator capable of delivering the specified power on a standby basis with an anticipated mean time between overhauls of no less than 5,000 hours operating with a load factor of 70%. Two like engines and two like generators shall be cited that have performed satisfactorily in a stationary power plant, independent and separate from the physical location of the manufacturer's and assembler's facilities, for standby without any failure to start, including all periodic exercise. Each like engine and generator shall have had no failures resulting in downtime for repairs in excess of 72 hours during two consecutive years of service. Like engines shall be of the same model, speed, bore, stroke, number and configuration of cylinders, and rated output capacity. Like generators shall be of the same model, speed, pitch, cooling, exciter, voltage regulator and rated output capacity.

1.4 GENERAL REQUIREMENTS

1.4.1 Engine-Generator Set

Each set shall consist of one engine, one generator, and one exciter mounted, assembled, and aligned on one base; and other necessary ancillary equipment which may be mounted separately. Sets having a capacity of 750 kW or smaller shall be assembled and attached to the base prior to shipping. Sets over 750 kW capacity may be shipped in sections. Each set component shall be environmentally suitable for the location shown and shall be the manufacturer's standard product offered in catalogs for commercial or industrial use. Any nonstandard products or components and the reason for their use shall be specifically identified in paragraph SUBMITTALS.

1.4.2 Nameplates

Each major component of this specification shall have the manufacturer's name, type or style, model or serial number and rating on a plate secured to the equipment. As a minimum, nameplates shall be provided for:

Engine	Relays
Generator	Transformers (CT & PT)
Regulators	Day tanks
Pumps and pump motors	Governors
Generator Breaker	Heat exchangers (other than base mounted)
Economizers	

Where the following equipment is not provided as a standard component by the diesel engine generator set manufacturer, the nameplate information may be provided in the maintenance manual in lieu of nameplates.

Battery charger	Heaters
Switchboards	Exhaust mufflers
Switchgear	Silencers
Battery	Exciters

1.4.3 Personnel Safety Devices

Exposed moving parts, parts that produce high operating temperatures, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. The safety devices shall be installed so that proper operation of the equipment is not impaired.

1.4.4 Verification of Dimensions

Before performing any work, the premises shall be visited and all details of the work verified. The Contracting Officer shall be advised in writing of any discrepancies.

1.4.5 Conformance to Codes and Standards

Where equipment is specified to conform to requirements of any code or standard such as UL, NEMA, etc., the design, fabrication and installation shall also conform to the code.

1.4.6 Site Welding

Structural members shall be welded in accordance with Section 05090 WELDING, STRUCTURAL. For all other welding, procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1. Welder qualification tests shall be performed for each welder whose qualifications are not in compliance with the referenced standards. The Contracting Officer shall be notified 24 hours in advance of qualification tests. The qualification tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record.

1.4.7 Vibration Limitation

The maximum engine-generator set vibration in the horizontal, vertical, and axial directions shall be limited to 6 mils (peak-peak RMS), with an overall velocity limit of 0.95 inches/second RMS, for all speeds through 110% of rated speed.

1.4.8 Vibration Isolation

The engine-generator set shall be provided with a vibration-isolation system in accordance with the manufacturer's standard recommendation. Vibration-isolation systems shall be designed and qualified (as an integral part of the base and mounting system in accordance with the seismic parameters specified. Where the vibration-isolation system does not secure the base to the structure floor or unit foundation, seismic restraints shall be provided in accordance with the seismic parameters specified.

1.4.9 Seismic Requirements

Seismic requirements shall be in accordance with Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT, 15070 SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT, and 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

1.4.10 Fuel Consumption

Engine fuel consumption shall not exceed the following maximum limits based on the conditions listed below.

Size Range Net kW	% of Rated Output Capacity	Fuel Usage LBS./kWH
300 - 999	75 and 100	0.575
	50	0.600

Conditions:

a. Net kW of the Set corrected for engine auxiliaries that are electrically driven, where kW is electrical kilowatt hours.

b. 19,350 Btu per pound high-heat value for fuel used.

c. Sea level operation.

d. Intake-air temperature not over 90 degrees F.

e. Barometric pressure of intake air not less than 28-1/4 inches of mercury.

1.4.11 Starting Time Requirements

Upon receipt of a signal to start, each engine generator set will start, reach rated frequency and voltage and be ready to assume load within the time specified. For standby sets used in emergency power applications, each engine generator set will start, reach rated frequency and voltage, and power will be supplied to the load terminals of the automatic transfer switch within the starting time specified.

1.4.12 Experience

Each component manufacturer shall have a minimum of 3 years experience in the manufacture, assembly and sale of components used with stationary diesel engine-generator sets for commercial and industrial use. The engine-generator set manufacturer/assembler shall have a minimum of 3 years experience in the manufacture, assembly and sale of stationary diesel engine-generator sets for commercial and industrial use.

1.4.13 Field Engineer

The engine-generator set manufacturer or assembler shall furnish a qualified field engineer to supervise the complete installation of the engine-generator set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment. The field engineer shall have attended the engine generator manufacturer's training courses on installation and operation and maintenance of engine generator sets.

1.5 STORAGE AND INSTALLATION

The Contractor shall properly protect material and equipment, in accordance with the manufacturers recommended storage procedures,before, during, and after installation. Stored items shall be protected from the weather and contamination. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

1.6 PAYMENT

No separate payment or direct payment will be made for the work covered under this section. Any such work shall be considered incidental to the applicable bid item to which the work pertains.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Filter Elements

Fuel-oil, lubricating-oil, and combustion-air filter elements shall be manufacturer's standard.

2.1.2 Instrument Transformers

ANSI C12.11.

2.1.3 Pipe

Fuel piping external to the engine-generator set shall be in accordance with Section 13202 Fuel Storage Systems. Unless otherwise indicated on the contract drawings the piping shall be as follows.

ASTM A 53, or ASTM A 106 steel pipe. Pipe smaller than 2 inches shall be Schedule 80. Pipe 2 inches and larger shall be Schedule 40.

a. Flanges and Flanged Fittings: ASTM A 181/A 181M, Class 60, or ASME B16.5, Grade 1, Class 150.

b. Pipe Welding Fittings: ASTM A 234/A 234M, Grade WPB or WPC, Class 150 or ASME B16.11, 3000 lb.

c. Threaded Fittings: ASME B16.3, Class 150.

d. Valves: MSS SP-80, Class 150.

e. Gaskets: Manufacturer's standard.

2.1.4 Pipe Hangers

MSS SP-58 and MSS SP-69.

2.1.5 Electrical Enclosures

NEMA ICS 6.

2.1.5.1 Power Switchgear Assemblies

NEMA SG 5.

2.1.5.2 Switchboards

NEMA PB 2.

2.1.5.3 Panelboards

NEMA PB 1.

2.1.6 Electric Motors

Electric motors shall conform to the requirements of NEMA MG 1. Motors shall have sealed ball bearings and a maximum speed of 1800 rpm. Motors used indoors shall have drip-proof frames; those used outside shall be totally enclosed. Alternating current motors larger than 1/2 Hp shall be of the squirrel-cage induction type for operation on 208 volts or higher, 60 Hz, and three-phase power. Alternating current motors 1/2 Hp or smaller, shall be suitable for operation on 120 volts, 60 Hz, and single-phase power. Direct current motors shall be suitable for operation on 125 volts.

2.1.7 Motor Controllers

Motor controllers and starters shall conform to the requirements of NFPA 70 and NEMA ICS 2.

2.2 ENGINE

***3**

Each engine shall operate on No. 2-D diesel fuel conforming to ASTM D 975, shall be designed for stationary applications and shall be complete with ancillaries. The engine shall be a standard production model described in the manufacturer's catalog. The engine shall be naturally aspirated, supercharged, or turbocharged. The engine shall be 4-stroke-cycle and compression-ignition type. The engine shall be vertical in-line, V- or opposed-piston type, with a solid cast block or individually cast cylinders. **The engine shall have a minimum of 6 cylinders.** Each block shall have a coolant drain port. Each engine shall be equipped with an overspeed sensor.

***3**

2.3 FUEL SYSTEM

The entire fuel system for the engine-generator set shall conform to the requirements of NFPA 30 , NFPA 37, 13202 FUEL STORAGE SYSTEM and contain the following elements.

2.3.1 Pumps

2.3.1.1 Main Pump

The engine shall be provided with an engine driven pump. The pump shall supply fuel from the day tank at a minimum rate sufficient to provide the amount of fuel required to meet the performance indicated within the parameter schedule. The fuel flow rate shall be based on meeting the load requirements and all necessary recirculation.

2.3.1.2 Auxiliary Fuel Pump

Auxiliary fuel pump shall be provided to maintain the required engine fuel pressure in the event the main pump fails. The auxiliary pump shall be driven by a dc electric motor powered by the starting/station batteries. The auxiliary pump shall be automatically actuated by a pressure-detecting device.

2.3.1.3 Tranfer and Overflow Pumps

The day tank shall be equipped with one transfer pump to retrieve fuel from the fuel storage tank. The transfer pump shall operate when the liqiud level in the day tank goes below 30 percent capacity and continue to operate until 90 percent capacity is reached. The transfer pump shall be mounted on the day tank. Additionally the day tank will be equipped with one overflow pump to return fuel back to the fuel storage tank. The return pump shall operate when liquid level in the day tank reaches 95 percent capacity and continue to operate until the liquid level returns to 90 percent capacity. The overflow pump can either be mounted on the day tank or in the return line. Transfer pump shall be 2 gpm gear pump with sufficient lift to transfer fuel as described above for the system indicated on the contract plans. Overflow pump shall be 4 gpm gear pump with sufficient lift to transfer fuel as described above for the system indicated on the contract plans. Each pump shall have at least a 1/3 HP motor capable of operating on 115 volts, 1 phase, 60 Hz.

2.3.2 Strainer

Strainer shall meet the requirements specified in Section 13202 FUEL STORAGE SYSTEMS.

2.3.3 Fuel Filter

A minimum of one full-flow fuel filter shall be provided for engine. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked.

2.3.4 Relief/Bypass Valve

A relief/bypass valve shall be provided to regulate pressure in the fuel supply line from the day tank, return excess fuel to the day tank to p revent the build-up of excessive pressure in the fuel line. Appropriate relief/bypass valves shall be provided to prevent damage to transfer pumps and piping connect to the day tank. All relief/bypass valves Section 13202 FUEL STORAGE SYSTEMS, paragraph PIPING COMPONENTS, sub-paragraph VALVES.

2.3.5 Solenoid Valve

Solenoid valve shall meet the requirements of Section 13202 FUEL STORAGE SYSTEMS, paragraph PIPING COMPONENTS, sub-paragraph VALVES. The valve shall open when the liqiud level in the day tank goes below 30 percent capacity and continue to close when 90 percent capacity is reached. The valve shall fail closed.

2.3.6 Check Valve

Check valves shall meet the requirements of The valve shall meet the requirements of Section 13202 FUEL STORAGE SYSTEMS, paragraph PIPING COMPONENTS, sub-paragraph VALVES.

2.3.7 Day Tank

A double wall remote day tank shall be provided that has a total capacity of 60 gal in primary tank. Secondary containment shall 150 percent capacity provided by the primary tank. Day tank shall be UL 142 listed. Day tank shall have an electronic control module. Each day tank shall be provided with connections for fuel supply line, equippment fuel supply and return lines, fuel overflow line, local fuel fill port, gauge, vent line, drain line, and float switch assemblies for control. A fuel return line cooler shall be provided as recommended by the manufacturer and assembler. The temperature of the fuel returning to the day tank shall be below the flash point of the fuel. The fuel fill line shall be accessible without opening the enclosure.

2.3.7.1 Drain Line

Each day tank drain line shall be accessible and equipped with a shutoff valve. Self-supporting day tanks shall be arranged to allow drainage into a 12 inch tall bucket.

2.3.7.2 Local Fuel Fill

Local fuel fill port on the day tank shall be provided with a screw-on cap.

2.3.7.3 Float Switches

a. Each day tank shall have a float-switch assemblies to perform the following functions:

(1) Signal the start of fuel flow into the day tank when the fuel level is at the "Low liquid" level mark, 30% of the rated tank capacity.

(2) Signal the stop of fuel flow into the day tank when the fuel level is at 90% of the rated tank capacity.

(3) Signal the "Overfill liquid level" alarm at 95% of the rated tank capacity.

(4) Signal the "Low liquid level" alarm at 30% of the rated tank capacity.

(5) Signal the "Critically low liquid level" alarm at less than 30% of the rated tank capacity.

2.3.7.4 Electronic Control Module (ECM)

The eletronic control module shall be UL 508 listed and have the following features.

(1) LED Display showing
- a. Unit status (on/off/standby)
- b. Transfer pump status (running/standby)
- c. Liquid level in primary tank
- d. Alarm Conditions
  1. High liquid level
  2. Low liquid level
  3. Critically low liguid level
  4. Liquid in secondary containment
  5. ECM status

(2) Manual Controls, (on/off/test)

(3) Automatic Controls
- a. Open the solenoid valve on the fuel supply line from the fuel storage tank on low liquid alarm.

b. Start supply transfer pump on low liquid level alarm
c. Stop supply transfer pump at 90 percent liquid level
d. Close the solenoid valve on the fuel supply line from the fuel storage tank at 90 percent liquid level.
e. Start return transfer pump on overfill liquid level alarm
f. Stop return transfer pump when liquid level returns to 90 percent.
g. Send signal to the Control and Instrumentation System specified in Section 16900 that attention is required at the day tank on overfill and critically low liquid levels alarm conditions.
h. Send signal to the Control and Instrumentation System specified in Section 16900 that attention is required at the day tank when liquid is sensed in the containment reservoir.

2.3.7.5 Arrangement

The fuel supply and return line from the day tank to the manufacturer's standard engine connection shall be welded pipe in accordance with Section 13202 FUEL STORAGE SYSTEMS.

2.3.8 Fuel Supply System

The fuel supply and return from the main storage of fuel to the day tank shall be as specified in Section 13202 FUEL STORAGE SYSTEMS.

2.4 LUBRICATION

Each engine shall have a separate lube-oil system conforming to NFPA 30 and NFPA 37. Each system shall be pressurized by engine-driven pumps. System pressure shall be regulated as recommended by the engine manufacturer. A pressure relief valve shall be provided on the crankcase for closed systems. The crankcase shall be vented in accordance with the manufacturer's recommendation except that it shall not be vented to the engine exhaust system. Crankcase breathers, if provided on engines installed in buildings or enclosures, shall be piped to vent to the outside. The system shall be readily accessible for service such as draining, refilling, etc. Each system shall permit addition of oil and have oil-level indication with the set operating. The system shall utilize an oil cooler as recommended by the engine manufacturer.

2.4.1 Lube-Oil Filter

One full-flow filter shall be provided for each pump. The filter shall be readily accessible and capable of being changed without disconnecting the piping or disturbing other components. The filter shall have inlet and outlet connections plainly marked.

2.4.2 Lube-Oil Sensors

Each engine shall be equipped with lube-oil pressure sensors. Pressure sensors shall be located downstream of the filters and provide signals for required indication and alarms.

2.5 COOLING

Each engine shall have its own cooling system. Each system shall operate automatically while its engine is running. The cooling system coolant shall use a combination of water and ethylene-glycol sufficient for freeze protection at the minimum winter outdoor temperature specified. The maximum temperature rise of the coolant across each engine shall not exceed that recommended and submitted in paragraph SUBMITTALS.

2.5.1 Coolant Pumps

Coolant pumps shall be the centrifugal type. Each engine shall have an engine-driven primary pump. Secondary pumps shall be electric motor driven and have automatic controllers.

2.5.2 Heat Exchanger

Each heat exchanger shall be of a size and capacity to limit the maximum allowable temperature rise in the coolant across the engine to that recommended and submitted in paragraph SUBMITTALS for the maximum summer outdoor design temperature and site elevation. Each heat exchanger shall be corrosion resistant, suitable for service in ambient conditions of application.

2.5.2.1 Remote Radiator

Heat exchanger may be factory coated with corrosive resistant film, provided that correction measures are taken to restore the heat rejection capability of the radiator to the initial design requirement via over sizing, or other compensating methods. Internal surfaces shall be compatible with liquid fluid coolant used. Materials and coolant are subject to approval by the Contracting Officer. Heat exchangers shall be pressure type incorporating a pressure valve, vacuum valve and a cap. Caps shall be designed for pressure relief prior to removal. Heat exchanger and the entire cooling system shall be capable of withstanding a minimum pressure of 15 psi . Heat exchanger shall have at least two tapped holes; one tapped hole shall be equipped with a drain cock, the rest shall be plugged. Heat exchanger shall be equipped an AC electric motor driven fan that has sufficient capacity to reject required heat from the coolant to the exterior of Control Building "B". The fan shall have sufficient power to overcome static pressure losses through the heat exchanger and the indicated duct work, louvers, etc. The heat exchanger shall be installed with Vibration-Isolation to seperated it from the building structure.

2.5.3 Thermostatic Control Valve

A modulating type, thermostatic control valve shall be provided in the coolant system to maintain the coolant temperature range submitted in paragraph SUBMITTALS.

2.5.4 Ductwork

Ductwork shall be as specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM except that a flexible connection shall be used to connect the duct to the remote radiator. Material for the connection shall be wire-reinforced glass. The connection shall be rendered as airtight as possible.

2.5.5 Temperature Sensors

Each engine shall be equipped with coolant temperature sensors. Temperature sensors shall provide signals for pre-high and high indication and alarms.

2.6 SOUND LIMITATIONS

***1**

The noise generated by the diesel generator set operating at 100 percent load shall not exceed the following sound pressure levels in any of the indicated frequencies when measured in a free field at a radial distance of 22.9 feet 7 meters at 45 degrees apart in all directions.

Frequency Band (Hz)	Maximum Acceptable Pressure Level (Decibels)
31	**>83_**
63	**84**
125	**83**
250	**84**
500	**85**
1,000	**86**
2,000	**86**
4,000	**79**
8,000	**69**

***1**

2.7 AIR INTAKE EQUIPMENT

Filters and silencers shall be provided in locations that are convenient for servicing. The silencer shall be of the high-frequency filter type, located in the air intake system as recommended by the engine manufacturer. Silencer shall be capable of reducing the noise level at the air intake so that the indicated pressure levels specified in paragraph SOUND LIMITATIONS will not be exceeded. A combined filter-silencer unit meeting requirements for the separate filter and silencer items may be provided. Expansion elements in air-intake lines shall be copper or rubber.

2.8 EXHAUST SYSTEM

Piping shall be supported to minimize vibration. Where a V-type engine is provided, a V-type connector, with necessary flexible sections and hardware, shall connect the engine exhaust outlets.

2.8.1 Flexible Sections and Expansion Joints

A flexible section shall be provided at each engine and an expansion joint at each muffler. Flexible sections and expansion joints shall have flanged connections. Flexible sections shall be made of convoluted seamless tube without joints or packing. Expansion joints shall be the bellows type. Expansion and flexible elements shall be stainless steel suitable for diesel-engine exhaust gas at the maximum exhaust temperature that is specified by the engine manufacturer. Expansion and flexible elements shall be capable of absorbing vibration from the engine and compensation for thermal expansion and contraction.

2.8.2 Exhaust Muffler

A chamber type exhaust muffler shall be provided. The muffler shall be constructed of welded steel and designed for inside mounting. Eyebolts, lugs, flanges, or other items shall be provided as necessary for support in the location and position indicated. Pressure drop through the muffler shall not exceed the recommendations of the engine manufacturer. Outside mufflers shall be zinc coated or painted with high temperature 1000 degrees F. resisting paint. The muffler and exhaust piping together shall reduce the noise level to less than the maximum acceptable level listed for sound limitations in paragraph SOUND LIMITATIONS. The muffler shall have a drain valve, nipple, and cap at the low-point of the muffler.

2.8.3 Exhaust Piping

Horizontal sections of exhaust piping shall be sloped downward away from the engine to a drip leg for collection of condensate with drain valve and cap. Changes in direction shall be long radius. Exhaust piping, mufflers and silencers installed inside any building shall be insulated in accordance with paragraph THERMAL INSULATION and covered to protect personnel. Vertical exhaust piping shall be provided with a hinged, gravity-operated, self-closing, rain cover.

***1**

2.9 NOT USED

2.10 NOT USED

***1**

2.11 STARTING SYSTEM

The starting system for standby engine generator sets used in emergency applications shall be in accordance with NFPA 99 and NFPA 110 and as follows.

2.11.1 Controls

An engine control switch shall be provided with functions including: run/start(manual), off/reset, and, automatic mode. Start-stop logic shall be provided for adjustable cycle cranking and cooldown operation. The logic shall be arranged for manual starting . Electrical starting systems shall be provided with an adjustable cranking limit device to limit cranking periods from 1 second up to the maximum duration.

2.11.2 Capacity

The starting system shall be of sufficient capacity, at the maximum indoor summer temperature specified to crank the engine without damage or overheating. The system shall be capable of providing a minimum of three cranking periods with 15 second intervals between cranks. Each cranking period shall have a maximum duration of 15 seconds.

2.11.3 Electrical Starting

Manufacturers recommended dc system, utilizing a negative circuit ground.

2.11.3.1 Battery

A starting battery system shall be provided and shall include the battery, battery rack, intercell connectors, spacers, automatic battery charger with overcurrent protection, metering and relaying. The battery shall be in accordance with SAE J 537. Critical system components (rack, protection, etc.) shall be sized to withstand the seismic acceleration forces specified. The battery shall be nickel-cadmium, with sufficient capacity, at the minimum indoor and maximum indoor temperature specified, to provide the specified cranking periods. Valve-regulated lead-acid batteries are not acceptable.

2.11.3.2 Battery Charger

A current-limiting battery charger, conforming to UL 1236, shall be provided and shall automatically recharge the batteries. The charger shall be capable of an equalize-charging rate for recharging fully depleted batteries within 8 hours and a floating charge rate for maintaining the batteries at fully charged condition. An ammeter shall be provided to indicate charging rate. A voltmeter shall be provided to indicate charging voltage. A timer shall be provided for the equalize-charging-rate setting. A battery is considered to be fully depleted when the output voltage falls to a value which will not operate the engine generator set and its components.

2.11.4 Starting Aids

The manufacturer shall provide one or more of other following methods to assist engine starting.

***1**

2.11.4.1 NOT USED

***1**

2.11.4.2 Jacket-Coolant Heaters

A thermostatically controlled electric heater shall be mounted in the engine coolant jacketing to automatically maintain the coolant within plus or minus 3 degrees F of the control temperature. The heater shall operate independently of engine operation so that starting times are minimized. Power for the heaters shall be 120 volts ac. The control temperature shall be the temperature recommended by the engine manufacturer to meet the starting time specified at the minimum winter outdoor temperature.

2.11.5 Exerciser

The exerciser shall be in accordance with Section 16410, AUTOMATIC TRANSFER AND BY-PASS/ISOLATION SWITCHES.

2.12 GOVERNOR

Each engine shall be provided with a governor which maintains the frequency within a bandwidth of the rated frequency, over a steady-state load range of zero to 100% of rated output capacity. The governor shall be configured for safe manual adjustment of the speed/frequency during operation of the engine-generator set, without special tools, from 90 to 110% of the rated speed/frequency, over a steady state load range of 0 to 100% or rated capacity.

2.12.1 Governor Performance

Isochronous governors shall maintain the midpoint of the frequency bandwidth at the same value for steady-state loads over the range of zero to 100% of rated output capacity.

2.13 GENERATOR

Each generator shall be of the synchronous type, one or two bearing, conforming to NEMA MG 1, equipped with winding terminal housings in accordance with NEMA MG 1, equipped with an amortisseur winding, and directly connected to the engine. Insulation shall be Class H . Generator design shall protect against mechanical, electrical and thermal damage due to vibration, 25% overspeeds, or voltages and temperatures at a rated output capacity 100% for standby applications. Generator ancillary equipment shall meet the short circuit requirements of NEMA MG 1. Frames shall be the drip-proof type.

2.13.1 Current Balance

At 100% rated output capacity, and load impedance equal for each of the 3 phases, the permissible current difference between any 2 phases shall not exceed 2% of the largest current on either of the 2 phases.

2.13.2 Voltage Balance

At any balanced load between 75 and 100% of rated output capacity, the difference in line-to-neutral voltage among the 3 phases shall not exceed 1% of the average line-to-neutral voltage. For a single-phase load condition, consisting of 25% load at unity power factor placed between any phase and neutral with no load on the other 2 phases, the maximum simultaneous difference in line-to-neutral voltage between the phases shall not exceed 3% of rated line to neutral voltage. The single-phase load requirement shall be valid utilizing normal exciter and regulator control. The interpretation of the 25% load for single phase load conditions means 25% of rated current at rated phase voltage and unity power factor.

2.13.3 Waveform

The deviation factor of the line-to-line voltage at zero load and at balanced rated output capacity shall not exceed 10%. The RMS of all harmonics shall be less than 5.0% and that of any one harmonic less than 3.0% of the fundamental at rated output capacity. Each engine-generator shall be designed and configured to meet the total harmonic distortion limits of IEEE Std 519.

2.14 EXCITER

The generator exciter shall be of the brushless type. Semiconductor rectifiers shall have a minimum safety factor of 300% for peak inverse voltage and forward current ratings for all operating conditions, including 110% generator output at 104 degrees F ambient. The exciter and regulator in combination shall maintain generator-output voltage within the limits specified.

2.15 VOLTAGE REGULATOR

Each generator shall be provided with a solid-state voltage regulator, separate from the exciter. The regulator shall maintain the voltage within a bandwidth of the rated voltage, over a steady-state load range of zero to 100% of rated output capacity. Regulator shall be configured for safe manual adjustment of the engine-generator voltage output without special tools, during operation, from 90 to 110% of the rated voltage over the steady state load range of 0 to 100% of rated output capacity. Regulation drift shall not exceed plus or minus 0.5% for an ambient temperature change of 68 degrees F.

2.15.1 Steady State Performance (Regulation or Voltage Droop)

The voltage regulator shall have a maximum droop of 2% of rated voltage over a load range from 0 to 100% of rated output capacity and automatically maintain the generator output voltage within the specified operational bandwidth.

2.16 GENERATOR ISOLATION AND PROTECTION

Devices necessary for electrical protection and isolation of each engine-generator set and its ancillary equipment shall be provided. The generator circuit breaker (IEEE Device 52) ratings shall be consistent with the generator rated voltage and frequency, with continuous, short circuit withstand, and interrupting current ratings to match the generator capacity. The generator circuit breaker shall be manually operated. A set of surge capacitors, to be mounted at the generator terminals shall be provided. Monitoring and control devices shall be as specified in paragraph GENERATOR PANEL.

2.17 SAFETY SYSTEM

Devices, wiring, remote panels, local panels, etc. shall be provided and installed as a complete system to automatically activate the appropriate signals and initiate the appropriate actions. The safety system shall be provided with a self-test method to verify its operability. Alarm signals shall have manual acknowledgment and reset devices. The alarm signal systems shall reactivate for new signals after acknowledgment is given to any signal. The systems shall be configured so that loss of any monitoring device shall be dealt with as an alarm on that system element. All alarms shall send a remote signal to the Lock Operator by way of the Control and Instrumentation system specified in Section 16900 to indicate attention is required for the generator and day tank.

2.17.1 Audible Signal

The audible alarm signal shall sound at a frequency of 70 Hz at a volume of 75 dB at 10 feet. The sound shall be continuously activated upon alarm and silenced upon acknowledgment. Signal devices shall be located as shown.

2.17.2 Visual Signal

The visual alarm signal shall be a panel light. The light shall be normally off, activated to be blinking upon alarm. The light shall change to continuously lit upon acknowledgement. If automatic shutdown occurs, the display shall maintain activated status to indicate the cause of failure and shall not be reset until cause of alarm has been cleared and/or restored to normal condition. Shutdown alarms shall be red; all other alarms shall be amber.

2.17.3 Alarms and Action Logic

2.17.3.1 Shutdown

Simultaneous activation of the audible signal, activation of the visual signal and remote signal , stopping the engine, and opening the generator main circuit breakers shall be accomplished.

2.17.3.2 Problem

Activation of the visual signal shall be accomplished.

2.17.4 Local Alarm Panel

A local alarm panel shall be provided with the following shutdown and alarm functions as indicated and including the listed Corps of Engineer requirements mounted either on or adjacent to the engine generator set.

Device/Condition /Function	What/Where/Size	NFPA 99	NFPA 110 Level 1	NFPA 110 Level 2	Corps of Engrs Required
Shutdowns w/Alarms					
High engine temperature	Automatic/jacket/ water/cylinder	SD/CP VA	SD/CP VA	SD/CP VA	SD VA
Low lube-oil pressure	Automatic/pressure/ level	SD/CP VA	SD/CP VA	SC/CP VA	SD VA
Overspeed Shutdown&	(110 percent ($\pm$ 2 % of rated speed)	SD/CP VA	SD/CP VA	SD/CP VA	SD VA

Device/Condition /Function	What/Where/Size	NFPA 99	NFPA 110 Level 1	NFPA 110 Level 2	Corps of Engrs Required
Alarm					
Overcrank, Failure to	Automatic/Failure to start	SD/CP VA	SD/CP VA	SD/CP VA	
start	when used		SD/CP VA	SD/CP VA	
Air shutdown damper (200-600kW)	When Used		SD/CP VA	SD/CP VA	
Red emergency stop switch	Manual Switch		SD/CP VA	SD/CP VA	SD VA
Alarms					
Low Coolant Temperature	jacket water	CP VA	CP VA	CP VA	
Pre-High Temperature	jacket water/ cylinder	CP VA	CP VA	CP VAO	CP VA
Pre-Low Lube-oil Pressure		CP VA			CP VA
High battery Voltage			CP VA	CP VAO	
Low battery Voltage			CP VA	CP VAO	
Battery charger AC Failure	AC supply not available		CP VA	CP VAO	
Control switch not in AUTO			CP VA	CP VAO	
Low starting Air pressure			CP VA	CP VAO	
Low starting hydraulic pressure			CP VA	CP VAO	

SD - Shut Down
CP - On Control Panel
VA - Visual Alarm
AA - Audible Alarm
O - Optional

2.17.5 Time-Delay on Alarms

For startup of the engine-generator set, time-delay devices shall be installed bypassing the low lubricating oil pressure alarm during cranking, and the coolant-fluid outlet temperature alarm. The lube-oil time-delay device shall return its alarm to normal status after the engine starts. The coolant time-delay device shall return its alarm to normal status 5 minutes after the engine starts.

2.18 ENGINE GENERATOR SET CONTROLS AND INSTRUMENTATION

Devices, wiring, remote panels, local panels, etc. shall be provided and installed as a complete system to automatically activate the appropriate signals and initiate the appropriate actions.

2.18.1 Controls

A local control panel shall be provided with controls in accordance with NFPA 110 level 2 and as follows mounted either on or adjacent to the engine generator set.

Device/Condition/ Function	Corps Requirement	NFPA 110 Level 1	NFPA 110 Level 2	MFG Offering
Controls				
Switch: run/start - off/reset - auto	CP			CP/STD
Emergency stop switch & alarm	CP			CP/STD
Lamp test/indicator test	CP	CP VA	CP VA	CP/STD
Common alarm contacts/ fault relay		X	X	CP/O
Panel lighting	CP			CP/STD
Audible alarm & silencing/reset switch	CP			
Voltage adjust for voltage regulator	CP			CP/STD
Pyrometer display w/selector switch	CP			
Remote emergency stop switch		CP VA	CP VA	
Remote fuel shutoff switch				
Remote lube-oil shutoff switch				

2.18.2 Engine Generator Set Metering and Status Indication

A local panel shall be provided with devices in accordance with NFPA 110 level 2 and as follows mounted either on or adjacent to the engine generator set.

Device/Condition/ Function	Corps Requirement	NFPA 110 Level 1	NFPA 110 Level 2	MFG Offering
Genset Status & Metering				
Genset supplying load		CP VA	CP VAO	CP VAO
System ready				CP/STD
Engine oil pressure	CP			CP/STD
Engine coolant temperature	CP			CP/STD
Engine RPM (tachometer)	CP			CP/STD
Engine run hours	CP			CP/STD
Pyrometer display w/selector switch	CP			
AC volts (generator), 3-phase	CP			CP/STD
AC amps (generator), 3 - phase	CP			CP/STD
Generator Frequency	CP			CP/STD
Phase selector switches (amps & volts)	CP			CP/STD
Watts/kW				CP/VA-O
Voltage Regulator Adjustment	CP			

X - Required

CP - On Control Panel
VA - Visual Alarm
AA - Audible Alarm
STD- Manufacturers Standard Offering
O - Optional

2.19 PANELS

Each panel shall be of the type and kind necessary to provide specified functions. Panels shall be mounted on the engine-generator set base by vibration/shock absorbing type mountings . Instruments shall be mounted flush or semiflush. Convenient access to the back of panels shall be provided to facilitate maintenance. Instruments shall be calibrated using recognized industry calibration standards. Each panel shall be provided with a panel identification plate which clearly identifies the panel function. Each instrument and device on the panel shall be provided with a plate which clearly identifies the device and its function as indicated. Switch plates shall clearly identify the switch-position function.

2.19.1 Enclosures

Enclosures shall be designed for the application and environment, conforming to NEMA ICS 6. Locking mechanisms are optional.

2.19.2 Analog

Analog electrical indicating instruments shall be in accordance with ANSI C39.1 with semiflush mounting. Switchboard, switchgear, and control-room panel-mounted instruments shall have 250 degree scales with an accuracy of not less than 99%. Unit-mounted instruments shall be the manufacturer's standard with an accuracy of not less than 98%. The instrument's operating temperature range shall be minus 4 to plus 158 degrees F. Distorted generator output voltage waveform of a crest factor less than 5 shall not affect metering accuracy for phase voltages, hertz and amps.

2.19.3 Parameter Display

Indication or readouts of the tachometer, lubricating-oil pressure, coolant temperature, ac voltmeter, ac ammeter, frequency meter, and safety system parameters shall be provided. A momentary switch shall be specified for other panels.

2.20 AUTOMATIC ENGINE-GENERATOR-SET SYSTEM OPERATION

Fully automatic operation shall be provided for the following operations: engine-generator set starting and load transfer upon loss of normal source; retransfer upon restoration of the normal source; sequential starting; and stopping of each engine-generator set after cool-down. Devices shall automatically reset after termination of their function.

2.20.1 Automatic Transfer Switch

Automatic transfer switches shall be in accordance with Section 16410 AUTOMATIC TRANSFER AND BY-PASS/INSOLATION SWITCHES.

2.20.2 Monitoring and Transfer

Devices shall be provided to monitor voltage and frequency for the normal power source and each engine-generator set, and control transfer from the normal source and retransfer upon restoration of the normal source. Functions, actuation, and time delays shall be as described in Section 16410 AUTOMATIC TRANSFER AND BY-PASS/ISOLATION SWITCHES.

2.21 MANUAL ENGINE-GENERATOR-SET SYSTEM OPERATION

Complete facilities shall be provided for manual starting and testing of each set without load, loading and unloading of each set.

2.22 BASE

The base shall be constructed of steel. The base shall be designed to rigidly support the engine-generator set, ensure permanent alignment of rotating parts, be arranged to provide easy access to allow changing of lube-oil, and ensure that alignment is maintained during shipping and normal operation. The base shall permit skidding in any direction during installation and shall withstand and mitigate the affects of synchronous vibration of the engine and generator. The base shall be provided with suitable holes for anchor bolts and jacking screws for leveling.

2.23 THERMAL INSULATION

Thermal insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.24 PAINTING AND FINISHING

The engine-generator set shall be cleaned, primed and painted in accordance with the manufacturer's standard color and practice.

2.25 FACTORY INSPECTION AND TESTS

The factory tests shall be performed on each engine-generator set. The component manufacturer's production line test is acceptable as noted. Each engine-generator set shall be run not less than 1 hour at rated output capacity prior to inspections. Inspections shall be completed and all necessary repairs made, prior to testing. Engine generator controls and protective devices that are provided by the generator set manufacturer as part of the standard package shall be used for factory tests. The Contracting Officer may provide one or more representatives to witness inspections and tests.

2.25.1 Factory Inspection

Inspections shall be performed prior to beginning and after completion of testing of the assembled engine-generator set. Inspectors shall look for leaks, looseness, defects in components, proper assembly, etc. and any item found to be in need of correction shall be noted as a necessary repair. The following checklist shall be used for the inspection:

INSPECTION ITEM	GOOD	BAD	NOTES
1. Drive belts			
2. Governor and adjustments			
3. Engine timing mark			
4. Starting motor			
5. Starting aids			
6. Coolant type and concentration			
7. Radiator drains			
8. Block coolant drains			
9. Coolant fill level			
10. All coolant line connections			
11. All coolant hoses			
12. Combustion air filter			
13. Combustion air silencer			
14. Lube oil type			
15. Lube oil sump drain			
16. Lube-oil filter			
17. Lube-oil-level indicator			
18. Lube-oil-fill level			
19. All lube-oil line connections			
20. All lube-oil lines			
21. Fuel type and amount			

22. All fuel-line connections
23. All fuel lines
24. Fuel filter
25. Coupling and shaft alignment
26. Voltage regulators
27. Battery-charger connections
28. All wiring connections
29. Instrumentation
30. Hazards to personnel
31. Base
32. Nameplates
33. Paint
34. Exhaust-heat recovery unit
35. Switchboard
36. Switchgear

2.25.2 Factory Tests

On engine-generator set tests where the engine and generator are required to be connected and operated together, the load power factor shall be .8 power factor. Electrical measurements shall be performed in accordance with IEEE Std 120. Definitions of terms are in accordance with IEEE Std 100. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulation shall be in accordance with IEEE Std 1. In the following tests where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. Tests specifically for the generator may be performed utilizing any prime mover.

a. Insulation Resistance for Stator and Exciter Test, IEEE Std 115 and IEEE Std 43, to the performance criteria in NEMA MG 1, Part 22. Generator manufacturer's production line test is acceptable.

b. High Potential Test, per IEEE Std 115 and NEMA MG 1, test voltage in accordance with NEMA MG 1. Generator manufacturer's production line test is acceptable.

c. Winding Resistance Test, Stator and Exciter, per IEEE Std 115. Generator manufacturer's production line test is acceptable.

d. Overspeed Vibration Test, per IEEE Std 115 to the performance criteria in NEMA MG 1. The test shall be performed at 110% of rated speed for 5 minutes. The vibration shall be measured at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Vibration amplitude and speed shall be recorded at one minute intervals.

e. Phase Balance Voltage Test, to the performance criteria specified in paragraph GENERATOR. This test can be performed with any prime mover. Generator manufacturer's production line test results are acceptable.

(1) Start and operate the generator at no load.

(2) Adjust a regulated phase voltage (line-to-neutral) to rated voltage.

(3) Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(4) Apply 75% rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(5) Apply rated load and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(6) Calculate average line-neutral voltage and percent deviation of individual line-neutral voltages from average for each load condition.

f. Current Balance on Stator Winding Test, by measuring the current on each phase of the winding with the generator operating at 100 % of Rated Output Capacity, with the load impedance equal for each of the three phases: to the performance criteria specified in paragraph GENERATOR.

g. Voltage Waveform Deviation and Distortion Test per IEEE Std 115 to the performance criteria specified in paragraph GENERATOR. High-speed recording instruments capable of recording voltage waveform deviation and all distortion, including harmonic distortion shall be used. Representation of results shall include appropriate scales to provide a means to measure and interpret results.

h. Voltage and Frequency Droop Test. Verify that the output voltage and frequency are within the specified parameters as follows:

(1.) With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency. Record the generator output frequency and line-line and line-neutral voltages.

(2.) Increase load to Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.

3. Calculate the percent droop for voltage and frequency with the following equations:

$$\text{Voltage droop \%} = \frac{\text{(No-Load Volts)} - \text{(Rated Capacity volts)}}{\text{(Service-Load Volts)}} \times 100$$

$$\text{Frequency droop \%} = \frac{\text{(No-Load Hertz)} - \text{(Rated Capacity hertz)}}{\text{(Service-Load hertz)}} \times 100$$

4. Repeat steps 1 through 3 two additional times without making

any adjustments.

i. Frequency and Voltage Stability and Transient Response. Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Tabular data shall include the following:

Ambient temperature (at 15 minute intervals).

Generator output current (before and after load changes).

Generator output voltage (before and after load changes).

Frequency (before and after load changes).

Generator output power (before and after load changes).

Graphic representations shall include the actual instrument trace of voltage and frequency showing: charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

(1.) Perform and record engine manufacturer's recommended prestarting checks and inspections.

(2.) Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.

(3.) With the unit at no load, apply the Maximum Step Load Increase.

(4.) Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.

(5.) Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100% of Service Load.

(6.) Apply the Maximum Step Load Increase.

(7.) Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.

(8.) Repeat steps 3. through 7.

j. Test Voltage Unbalance with Unbalanced Load (Line-to-Neutral) to the performance criteria specified in paragraph GENERATOR. Prototype test data is acceptable in lieu of the actual test. This test may be performed using any prime mover.

(1.) Start and operate the generator set at rate voltage, no load, rated frequency, and under control of the voltage regulator. Read and record the generator frequency, line-to-neutral voltages, and the line-to-line voltages.

(2.) Apply the specified load between terminals L_1-L_2, L_2-L_0, and L_3-L_0 in turn. Record all instrument readings at each line-neutral condition.

(3.) Express the greatest difference between any two of the line-to-line voltages and any two of the line-to-neutral voltages as a percent of rated voltage.

(4.) Compare the largest differences expressed in percent with the maximum allowable difference specified.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION

Installation shall provide clear space for operation and maintenance in accordance with NFPA 70 and IEEE C2. Installation of pipe, duct, conduit, and ancillary equipment shall be configured to facilitate easy removal and replacement of major components and parts of the engine-generator set.

3.2 PIPING INSTALLATION

Fuel piping external to the engine generator set shall be installed in accordance with section 13202 FUEL STORAGE SYSTEM. Piping shall be welded. Connections at valves shall be flanged. Connections at equipment shall be flanged except that connections to the diesel engine may be threaded if the diesel-engine manufacturers standard connection is threaded. Except where otherwise specified, welded flanged fittings shall be utilized to allow for complete dismantling and removal of each piping system from the facility without disconnecting or removing any portion of any other system's equipment or piping. Connections to equipment shall be made with vibration-isolation-type flexible connectors. Piping and tubing shall be supported and aligned to prevent stressing of flexible hoses and connectors. Pipes extending through the roof shall be properly flashed. Piping shall be installed clear of windows, doors and openings, to permit thermal expansion and contraction without damage to joints or hangers, and shall be installed with a 1/2 inch drain valve with cap at each low point.

3.2.1 Support

Hangers, inserts, and supports shall be of sufficient size to accommodate any insulation and shall conform to MSS SP-58 and MSS SP-69. Supports shall be spaced not more than 7 feet on center for pipes 2 inches in diameter or less, not more than 12 feet on center for pipes larger than 2 inches but smaller than 4 inches in diameter, and not more than 17 feet on center for pipes larger than 4 inches in diameter. Supports shall be provided at pipe bends or change of direction.

3.2.1.1 Ceiling and Roof

Exhaust piping shall be supported with appropriately sized Type 41 single pipe roll and threaded rods; all other piping shall be supported with appropriately sized Type 1 clevis and threaded rods.

3.2.1.2 Wall

Wall supports for pipe shall be made by suspending the pipe from appropriately sized Type 33 brackets with the appropriate ceiling and roof pipe supports.

3.2.2 Flanged Joints

Flanges shall be Class 125 type, drilled, and of the proper size and configuration to match the equipment and diesel engine connections. Flanged joints shall be gasketed and made up square and tight.

3.2.3 Cleaning

After fabrication and before assembly, piping interiors shall be manually wiped clean of debris.

3.2.4 Pipe Sleeves

Pipes passing through construction such as ceilings, floors, or walls shall be fitted with sleeves. Each sleeve shall extend through and be securely fastened in its respective structure and shall be cut flush with each surface. The structure shall be built tightly to the sleeve. The inside diameter of each sleeve shall be minimum 1/2 inch, and where pipes pass through combustible materials 1 inch larger than the outside diameter of the passing pipe or pipe insulation/covering.

3.3 ELECTRICAL INSTALLATION

Electrical installation shall comply with NFPA 70, IEEE C2, and Section 16415 ELECTRICAL WORK, INTERIOR.

3.3.1 Vibration Isolation

Flexible fittings shall be provided for conduit, cable trays, and raceways attached to engine-generator sets. Metallic conductor cables installed on the engine generator set and from the engine generator set to equipment not mounted on the engine generator set shall be flexible stranded conductor. Terminations of conductors on the engine generator set shall be crimp-type terminals or lugs.

3.4 FIELD PAINTING

Field painting shall be as specified in Section 09900 PAINTING, GENERAL.

3.5 ONSITE INSPECTION AND TESTS

3.5.1 Test Conditions

3.5.1.1 Data

Measurements shall be made and recorded of all parameters necessary to verify that each set meets specified parameters. If the results of any test step are not satisfactory, adjustments, replacements, or repairs shall be made and the step repeated until satisfactory results are obtained. Unless otherwise indicated, data shall be recorded in 15 minute intervals during engine-generator set operation and shall include: readings of all engine-generator set meters and gauges for electrical and power parameters; oil pressure; ambient temperature; and engine temperatures available from meters and gauges supplied as permanent equipment on the engine-generator set.Electrical measurements shall be performed in accordance with IEEE Std 120. Definitions of terms are in accordance with IEEE Std 100. Temperature limits in the rating of electrical equipment and for the evaluation of electrical insulations shall be in accordance with IEEE Std 1.

3.5.1.2 Power Factor

***1**

For all engine-generator set operating tests the load power factor shall be **1.0** power factor.

***1**

3.5.1.3 Contractor Supplied Items

The Contractor shall provide equipment and supplies required for inspections and tests including fuel, test instruments, and loadbanks at the specified power factors.

3.5.1.4 Instruments

Readings of panel gauges, meters, displays, and instruments provided as permanent equipment shall be verified during test runs, using test instruments of greater precision and accuracy. Test instrument accuracy shall be within the following: current plus or minus 1.5%, voltage plus or minus 1.5%, real power plus or minus 1.5%, reactive power plus or minus 1.5%, power factor plus or minus 3%, frequency plus or minus 0.5%. Test instruments shall be calibrated by a recognized standards laboratory within 30 days prior to testing.

3.5.1.5 Sequence

The sequence of testing shall be as specified in the approved testing plan unless variance is authorized by the Contracting Officer. Field testing shall be performed in the presence of the Contracting Officer. Tests may be scheduled and sequenced in order to optimize run-time periods; however, the following general order of testing shall be followed: Construction Tests; Inspections; Pre-operational Tests; Safety Run Tests; Performance Tests; and Final Inspection.

3.5.2 Construction Tests

Individual component and equipment functional tests for fuel piping, coolant piping, and lubricating-oil piping, electrical circuit continuity, insulation resistance, circuit protective devices, and equipment not provided by the engine-generator set manufacturer shall be performed prior to connection to the engine-generator set.

3.5.2.1 Piping Test

a. Lube-oil and fuel-oil piping shall be flushed with the same type of fluid intended to flow through the piping, until the outflowing fluid has no obvious sediment or emulsion.

b. Fuel piping which is external to the engine-generator set shall be tested in accordance with NFPA 30 and Section 13202 FUEL STORAGE SYSTEMS. All remaining piping which is external to the engine-generator set shall be pressure tested with air pressure at 150% of the maximum anticipated working pressure, but not less than 150 psi, for a period of 2 hours to prove the piping has no leaks. If piping is to be insulated, the test shall be performed before the insulation is applied.

3.5.2.2 Electrical Equipment Tests

a. Low-voltage cable insulation integrity tests shall be performed for cables connecting the generator breaker to the automatic transfer switch . Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

R in megohms = (rated voltage in kV + 1) x 304,800/(length of cable in meters)

R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet)

Each cable failing this test shall be repaired or replaced. The repair cable shall be retested until failures have been eliminated.

b. Not Used

c. Ground-Resistance Tests. The resistance of each grounding electrode shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the requirements resistance, but the specified number of electrodes must still be provided as follows:

(1.) Single rod electrode - 25 ohms.

(2.) Multiple rod electrodes - 25 ohms.

(3.) Ground mat - 25 ohms.

d. Circuit breakers and switchgear shall be examined and tested in accordance with the manufacturer's published instructions for functional testing.

3.5.3 Inspections

The following inspections shall be performed jointly by the Contracting Officer and the Contractor, after complete installation of each engine-generator set and its associated equipment, and prior to startup of the engine-generator set. Checks applicable to the installation shall be performed. The results of those which are physical inspections (I) shall be documented by the Contractor and submitted in accordance with paragraph SUBMITTALS. The Contractor shall present manufacturer's data for the inspections designated (D) at the time of inspection. Inspections shall verify that equipment type, features, accessibility, installation and condition are in accordance with the contract specification. Manufacturer's statements shall certify provision of features which cannot be verified visually.

1. Drive belts.	(I)
2. Governor type and features.	(I)
3. Engine timing mark.	(I)
4. Starting motor.	(I)
5. Starting aids.	(I)
6. Coolant type and concentration.	(D)
7. Radiator drains.	(I)
8. Block coolant drains.	(I)
9. Coolant fill level.	(I)
10. Coolant line connections.	(I)
11. Coolant hoses.	(I)
12. Combustion air filter.	(I)
13. Intake air silencer.	(I)
14. Lube oil type.	(D)
15. Lube oil sump drain.	(I)
16. Lube-oil filter.	(I)
17. Lube-oil level indicator.	(I)
18. Lube-oil fill level.	(I)
19. Lube-oil line connections.	(I)
20. Lube-oil lines.	(I)

21. Fuel type. (D)
22. Fuel-level. (I)
23. Fuel-line connections. (I)
24. Fuel lines. (I)
25. Fuel filter. (I)
26. Access for maintenance. (I)
27. Voltage regulator. (I)
28. Battery-charger connections. (I)
29. Wiring & terminations. (I)
30. Instrumentation. (I)
31. Hazards to personnel. (I)
32. Base. (I)
33. Nameplates. (I)
34. Paint. (I)
35. Exhaust-heat system. (I)
36. Exhaust muffler. (I)
37. Switchboard. (I)
38. Switchgear. (I)
39. Access provided to controls. (I)
40. Enclosure is weather resistant. (I)
41. Engine & generator mounting bolts (application). (I)

3.5.4 Pre-operational Tests

3.5.4.1 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings shall be implemented in accordance with the installation coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE ANSI/IEEE C57.13.1.

3.5.4.2 Insulation Test

Generator and exciter circuits insulation resistance shall be tested in accordance with IEEE Std 43. Stator readings shall be taken at the circuit breaker, to include generator leads to automatic transfer switch. Results of insulation resistance tests shall be recorded. Readings shall be within limits specified by the manufacturer. Mechanical operation, insulation resistance, protective relay calibration and operation, and wiring continuity of automatic transfer switch assembly shall be verified. Precautions shall be taken to preclude damaging generator components during test.

3.5.4.3 Engine-Generator Connection Coupling Test

When the generator provided is a two-bearing machine, the engine-generator connection coupling shall be inspected and checked by dial indicator to prove that no misalignment has occurred. The dial indicator shall measure variation in radial positioning and axial clearance between the coupling halves. Readings shall be taken at four points, spaced 90 degrees apart. Solid couplings and pin-type flexible couplings shall be aligned within a total indicator reading of 0.0005 to 0.001 inch for both parallel and angular misalignment. For gear-type or grid-type couplings, 0.002 inch will be acceptable.

3.5.5 Safety Run Test

For the following tests, if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries, the associated safety tests shall be repeated.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections.

b. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

c. Activate the manual emergency stop switch and verify that the engine stops.

d. Remove the high and pre-high lubricating oil temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

e. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine-generator set at no load until the output voltage and frequency stabilize. Monitor the temporarily installed temperature gauges. If either temperature reading exceeds the value required for an alarm condition, activate the manual emergency stop switch.

f. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

g. Remove the high and pre-high coolant temperature sensing elements from the engine and temporarily install a temperature gauge in their normal locations on the engine (required for safety, not for recorded data). Where necessary provide temporary wiring harness to connect the sensing elements to their permanent electrical leads.

h. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period. Operate the engine generator-set at no load until the output voltage and frequency stabilize.

i. Immerse the elements in a vessel containing controlled-temperature hot oil and record the temperature at which the pre-high alarm activates and the temperature at which the engine shuts down. Remove the temporary temperature gauges and reinstall the temperature sensors on the engine.

j. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

k. Operate the engine generator-set for at least 2 hours at 75% of Service Load.

l. Verify proper operation and setpoints of gauges and instruments.

m. Verify proper operation of ancillary equipment.

n. Manually adjust the governor to increase engine speed past the overspeed limit. Record the RPM at which the engine shuts down.

o. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75% of Service Load.

p. Manually adjust the governor to increase engine speed to within 2% of the overspeed trip speed previously determined and operate at that point for 5 minutes. Manually adjust the governor to the rated frequency.

q. Manually fill the day tank to a level above the overfill limit. Record the level at which the overfill alarm sounds. Verify shutdown of the fuel transfer pump. Drain the day tank down below the overfill limit.

r. Shut down the engine. Remove the time-delay low lube oil pressure alarm bypass and try to start the engine.

s. Attach a manifold to the engine oil system (at the oil pressure sensor port) that contains a shutoff valve in series with a connection for the engine's oil pressure sensor followed by an oil pressure gauge ending with a bleed valve. The engine's oil pressure sensor shall be moved from the engine to the manifold. The manifold shutoff valve shall be open and bleed valve closed.

t. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 75% of Service Load.

u. Close the manifold shutoff valve. Slowly allow the pressure in the manifold to bleed off through the bleed valve while watching the pressure gauge. Record the pressure at which the engine shuts down. Catch oil spillage from the bleed valve in a container. Add the oil from the container back to the engine, remove the manifold, and reinstall the engine's oil pressure sensor on the engine.

v. Start the engine, record the starting time, make and record engine manufacturer's after-starting checks and inspections and operate the engine generator-set for at least 15 minutes at 100% of Service Load. Record the maximum sound level in each frequency band at a distance of 75 feet from the end of the exhaust and air intake piping directly along the path of intake and discharge for horizontal piping; or at a radius of 75 feet from the engine at 45 degrees apart in all directions for vertical piping. The muffler and air intake silencer shall be modified or replaced as required to meet the sound limitations of this specification. If the sound limitations can not be obtained by modifying or replacing the muffler and air intake silencer, the contractor shall notify the Contracting Officers Representative and provide a recommendation for meeting the sound limitations.

w. Manually drain off fuel slowly from the day tank to empty it to below the low fuel level limit and record the level at which the audible alarm sounds. Add fuel back to the day tank to fill it above low level alarm limits.

3.5.6 Performance Tests

In the following tests, where measurements are to be recorded after stabilization of an engine-generator set parameter (voltage, frequency, current, temperature, etc.), stabilization is considered to have occurred when measurements are maintained within the specified bandwidths or tolerances, for a minimum of four consecutive readings. For the following tests, if any parts are changed, or adjustments made to the generator set, its controls, or auxiliaries, the associated tests shall be repeated.

3.5.6.1 Continuous Engine Load Run Test

Test the engine-generator set and ancillary systems at service load to demonstrate durability; verify that heat of extended operation does not adversely affect or cause failure in any part of the system; and check all parts of the system. If the engine load run test is interrupted for any reason, the entire test shall be repeated. The engine load run test shall be accomplished principally during daylight hours, during warm weather months, May through August. After each change in load in the following test, measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the allowable range. Data taken at 15 minute intervals shall include the following:

Electrical: Output amperes, voltage, real and reactive power, power factor, frequency.

Pressure: Lube-oil.

Temperature: Coolant.
Lube-oil.
Exhaust.
Ambient.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections. Include as a minimum checking of coolant fluid, fuel, and lube-oil levels.

b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warmup period.

c. Operate the engine generator-set for 2 hours at 75% of Service Load.

d. Increase load to 100% of Service Load and operate the engine generator-set for 4 hours.

e. Not Used

f. Decrease load to 100% of Service Load and operate the engine generator-set for 2 hours or until all temperatures have stabilized.

g. Remove load from the engine-generator set.

3.5.6.2 Voltage and Frequency Droop Test

For the following steps, verify that the output voltage and frequency return to and stabilize within the specified bandwidth values following each load change. Record the generator output frequency and line-line and line-neutral voltages following each load change.

a. With the generator operating at no load, adjust voltage and frequency to rated voltage and frequency.

b. Increase load to 100% of Rated Output Capacity. Record the generator output frequency and line-line and line-neutral voltages.

c. Calculate the percent droop for voltage and frequency with the following equations.

$$\text{Voltage droop \%} = \frac{\text{No-load volts - rated output capacity volts}}{\text{Rated output capacity volts}} \times 100$$

$$\text{Frequency droop \%} = \frac{\text{No load hertz - rated output capacity hertz}}{\text{Rated output capacity volts}} \times 100$$

d. Repeat steps a. through c. two additional times without making any adjustments.

3.5.6.3 Voltage Regulator Range Test

a. While operating at no load, verify that the voltage regulator adjusts from 90% to 110% of rated voltage.

b. Increase load to 100% of Rated Output Capacity. Verify that the voltage regulator adjusts from 90% to 110% of rated voltage.

3.5.6.4 Governor Adjustment Range Test

a. While operating at no load, verify that the governor adjusts from 90% to 110% of rated frequency.

b. Increase load to 100% of Rated Output Capacity. Verify that the governor adjusts from 90% to 110% of rated frequency.

3.5.6.5 Frequency and Voltage Stability and Transient Response

Verify that the engine-generator set responds to addition and dropping of blocks of load in accordance with the transient response requirements. Document maximum voltage and frequency variation from bandwidth and verify that voltage and frequency return to and stabilize within the specified bandwidth, within the specified response time period. Document results in tabular form and with high resolution, high speed strip chart recorders or comparable digital recorders, as approved by the Contracting Officer. Tabular data shall include the following:

(1.) Ambient temperature (at 15 minute intervals).

(2.) Generator output current (before and after load changes).

(3.) Generator output voltage (before and after load changes).

(4.) Frequency (before and after load changes).

(5.) Generator output power (before and after load changes.

(6.) Graphic representations shall include the actual instrument trace of voltage and frequency showing:

Charts marked at start of test; observed steady-state band; mean of observed band; momentary overshoot and undershoot (generator terminal voltage and frequency) and recovery time for each load change together with the voltage and frequency maximum and minimum trace excursions for each steady state load condition prior to and immediately following each load change. Generator terminal voltage and frequency transient recovery time for each step load increase and decrease.

a. Perform and record engine manufacturer's recommended prestarting checks and inspections.

b. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warm-up period and no load. Verify stabilization of voltage and frequency within specified bandwidths.

c. With the unit at no load, apply the Maximum Step Load Increase.

d. Apply load in steps equal to the Maximum Step Load Increase until the addition of one more step increase will exceed the Service Load.

e. Decrease load to the unit such that addition of the Maximum Step Load Increase will load the unit to 100% of Service Load.

f. Apply the Maximum Step Load Increase.

g. Decrease load to zero percent in steps equal to the Maximum Step Load Decrease.

h. Repeat steps c. through g.

3.5.7 Parallel Operation Test (Commercial Source)

Connect each set parallel with the commercial power source. Operate in parallel for 15 minutes. Verify stabilization of voltage and frequency within specified bandwidths. Record the output voltage, frequency, and loading to demonstrate ability to synchronize with the commercial power source.

3.5.8 Final Testing and Inspection

a. Start the engine, record the starting time, make and record all engine manufacturer's after-starting checks and inspections during a reasonable warm-up period.

b. Increase the load in steps no greater than the Maximum Step Load Increase to 100% of Service Load, and operate the engine-generator set for at least 30 minutes. Measure the vibration at the end bearings (front and back of engine, outboard end of generator) in the horizontal, vertical, and axial directions. Verify that the vibration is within the same range as previous measurements and is within the required range.

c. Remove load and shut down the engine-generator set after the recommended cool down period.

d. Remove the lube oil filter and have the oil and filter examined by the engine manufacturer for excessive metal, abrasive foreign particles, etc. Any corrective action shall be verified for effectiveness by running the engine for 8 hours at Service Load, then re-examining the oil and filter.

e. Remove the fuel filter and examine the filter for trash, abrasive foreign particles, etc.

f. Visually inspect and check engine and generator mounting bolts for tightness and visible damage.

g. Replace air, oil, and fuel filters with new filters.

3.6 POSTED DATA AND INSTRUCTIONS

Posted Data and Instructions shall be posted prior to field acceptance testing of the engine generator set. Two sets of instructions/data shall be typed and framed under weatherproof laminated plastic, and posted side-by-side where directed. First set shall include a one-line diagram, wiring and control diagrams and a complete layout of the system. Second set of shall include the condensed operating instructions describing manufacturer's pre-start checklist and precautions; startup procedures for test-mode, manual-start mode, and automatic-start mode (as applicable); running checks, procedures, and precautions; and shutdown procedures, checks, and precautions. Instructions shall include procedures for interrelated equipment (such as heat recovery systems, co-generation, load-shedding, and automatic transfer switches).

3.7 ONSITE TRAINING

The Contractor shall conduct training course for operating staff as designated by the Contracting Officer. The training period shall consist of a total 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance. All operation and maintenance manuals shall bee approved and made available for the training course. All posted instructions shall be approved and posted prior to the beginning date of the training course. The training course schedule shall be coordinated with the Using Service's work schedule, and submitted for approval 14 days prior to beginning date of proposed beginning date of training. The course instructions shall cover pertinent points involved in operating, starting, stopping, servicing the equipment, as well as major elements of the operation and maintenance manuals. Additionally, the course instructions shall demonstrate routine maintenance procedures as described in the operation and maintenance manuals. Two copies of a video tape of the manufacturers operating and maintenance training course shall be submitted.

3.8 ACCEPTANCE

Final acceptance of the engine-generator set will not be given until the contractor has successfully completed all tests and all defects in installation material or operation have been corrected.

-- End of Section --

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SECTION 16751

CLOSED CIRCUIT TELEVISION SYSTEMS
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PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 15	Radio Frequency Devices

DEPARTMENT OF DEFENSE (DOD)

DOD 3235.1	(Rev H) Test & Evaluation of System Reliability, Availability and Maintainability - A Primer

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA 170	(1957) Electrical Performance Standards - Monochrome Television Studio Facilities
EIA ANSI/EIA/TIA-232-F	(1997) Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
EIA ANSI/EIA-310-D	(1992) Cabinets, Racks, Panels, and Associated Equipment
EIA ANSI/EIA-330	(1968) Electrical Performance Standards for Closed Circuit Television Camera 525/60 Interlaced 2:1
EIA ANSI/EIA-375-A-1976	(1974) Electrical Performance Standards for Direct View Monochrome Closed Circuit Television Monitors 525/60 Interlaced 2:1

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1997) National Electrical Safety Code
IEEE C62.41	(1991; Rev 1995) Surge Voltages in Low-Voltage AC Power Circuits

IEEE Std 142	(1991) IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)

UNDERWRITERS LABORATORIES (UL)

UL 6	(1997) Rigid Metal Conduit
UL 1410	(1997) Television Receivers and High-Voltage Video Products

1.2 SYSTEM DESCRIPTION

1.2.1 General

The Contractor shall configure the system as described and shown. All television equipment shall conform to EIA 170 specifications. The system shall include all connectors, adapters, and terminators necessary to interconnect all equipment. The Contractor shall also supply all cabling necessary to interconnect the closed circuit television (CCTV) equipment installed in the Security Center, and interconnect equipment installed at remote control/monitoring stations.

1.2.2 Not Used

1.2.3 Power Line Surge Protection

All equipment connected to AC power shall be protected from surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used for surge protection.

1.2.4 Not Used

1.2.5 Control Line Surge Protection

All cables and conductors, except fiber optic cables, which serve as communication, control, or signal lines shall be protected against surges and shall have surge protection installed at each end. Protection shall be furnished at the equipment and additional triple electrode gas surge protectors rated for the application on each wireline circuit shall be installed within 3 feet of the building cable entrance. Fuses shall not be used for surge protection. The inputs and outputs shall be tested in both normal mode and common mode using the following waveforms:

a. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond rise time by 20 microsecond pulse width waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

1.2.6 Power Line Conditioners

A power line conditioner shall be furnished for the security console CCTV equipment. The power line conditioner shall be of the ferroresonant design, with no moving parts and no tap switching, while electrically isolating the secondary from the power line side. The power line conditioner shall be sized for 125 percent of the actual connected kVA load. Characteristics of the power line conditioner shall be as follows:

a. At 85 percent load, the output voltage shall not deviate by more than plus or minus 1 percent of nominal when the input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.

b. During load changes of zero to full load, the output voltage shall not deviate by more than plus or minus 3 percent of nominal. Full correction of load switching disturbances shall be accomplished within 5 cycles, and 95 percent correction shall be accomplished within 2 cycles of the onset of the disturbance.

c. Total harmonic distortion shall not exceed 3-1/2 percent at full load.

1.2.7 Video and Control Signal Data Transmission Media

The Contractor shall provide a video and data and controlsignal transmission system as specified herein and Section 16768.

1.2.8 Environmental Conditions

1.2.8.1 Field Equipment

The cameras and all other field equipment shall be rated for continuous operation under ambient environmental conditions of 14 degrees to 120 degrees F using no auxiliary heating or cooling equipment. Equipment shall be rated for continuous operation under the ambient environmental temperature, humidity, wind loading, ice loading, and vibration conditions specified or encountered for the installed location.

1.2.8.2 NOT USED

1.2.8.3 NOT USED

1.2.9 Electrical Requirements

Electrically powered CCTV equipment shall operate on 120 volt 60 Hz AC sources as shown. Equipment shall be able to tolerate variations in the voltage source of plus or minus 10 percent, and variations in the line frequency of plus or minus 2 percent with no degradation of performance.

All electrical and electronic equipment in the console shall be powered from an UPS. The UPS shall provide 2 hours battery back-up in the event of primary failure. Batteries shall be sealed non-outgassing type.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Data

Group I Technical Data Package;GA, ED.

System Drawings;GA, ED.

Six copies of the data package shall be provided. The data package shall include the following:

a. System block diagram.

b. CCTV system wiring diagrams.

c. Camera wiring and installation drawings.

d. Pan/tilt mount wiring and installation drawings.

e. Interconnection with video signal transmission system, block diagrams and wiring diagrams.

f. Surge protection device installation.

Manufacturers' Data;GA, ED.

The data package shall include manufacturers' data for all materials and equipment and security center equipment provided under this specification.

System Description and Analyses;GA, ED.

The data package shall include complete system descriptions, analyses and calculations used in sizing the equipment required by these specifications. Descriptions and calculations shall show how the equipment will operate as a system to meet the performance of this specification. The data package shall include the following:

a. Switcher matrix size.

b. Camera call-up response time.

c. System start up and shutdown operations.

d. Switcher programming instructions.

e. Switcher operating and maintenance instructions.

f. Manuals for CCTV equipment.

g. Data entry forms.

Software Data;GA, ED.

The data package shall consist of descriptions of the operation and capability of system and application software as specified.

Overall System Reliability Calculations;GA, ED.

The data package shall include all manufacturer's reliability data and calculations required to show compliance with the specified reliability. The reliability data shall be prepared using DOD 3235.1 as a guide. The calculations shall be based on all CCTV equipment associated with one camera circuit and the console CCTV equipment, excluding the data transmission media (DTM).

Certifications;GA, ED.

All specified manufacturer's certifications shall be included with the data package.

Group IV Technical Data Package;GA, ED.

The Contractor shall prepare test procedures and reports for the performance verification test and the endurance test. The Contractor shall deliver the performance verification test and endurance test procedures to the Government for approval. Six copies shall be provided. After receipt by the Contractor of written approval of the test procedures, the Contractor may schedule the tests. The contractor shall provide a report detailing the results of the field test and a video tape as specified in paragraph "Contractor's Field Testing." The final performance verification and endurance test report shall be delivered after completion of the tests.

Operation and Maintenance Manuals;GA, RE.

A draft copy of the operation and maintenance manuals, as specified for the Group V technical data package, shall be delivered to the Government prior to beginning the performance verification test for use during site testing.

Training Documentation;GA, RE.

Lesson plans and training manuals for the training phases, including type of training to be provided with a sample training report, and a list of reference material, shall be delivered for approval.

Group V Technical Data Package;GA, RE.

Six final copies of each of the manuals as specified bound in hardback, loose-leaf binders, shall be delivered to the Government within 30 days after completing the endurance test. The draft copy used during site testing shall be updated with any changes required prior to final delivery of the manuals. Each manual's contents shall be identified on the cover.

The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representatives for each item of equipment for each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the endurance test shall include all modifications made during installation, checkout, and acceptance.

Hardware Manual;GA, RE.

A manual shall describe all equipment furnished, including:

a. General hardware description and specifications.

b. Installation and checkout procedures.

c. Equipment electrical schematics and layout drawings.

d. System schematics and wiring lists.

e. System setup procedures.

f. Manufacturer's repair parts list indicating sources of supply.

g. Interface definition.

Software Manual;GA, RE.

The software manual shall describe the functions of all software, and shall include all other information necessary to enable proper loading, testing and operation, including:

a. Definitions of terms and functions.

b. Procedures for system generation.

c. Description of implementation of the program.

d. Description of required sequences.

e. Directory of all disk files.

f. Description of all communications protocols, including data formats, command characters, and a sample of each type of data transfer.

Operator's Manual;GA, RE.

The operator's manual shall explain all procedures and instructions for operation of the system including:

a. Video switcher.

b. Cameras and video recording equipment.

c. Use of the software.

d. Operator commands.

e. System start-up and shut-down procedures.

f. Recovery and restart procedures.

Maintenance Manual;GA, RE.

The maintenance manual shall describe maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

Final System Drawings;GA, RE.

The Contractor shall maintain a separate set of drawings, elementary diagrams and wiring diagrams of the CCTV system to be used for final system drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the CCTV system and shall be delivered to the Government with the final endurance test report. In addition to being complete and accurate, this set of drawings shall be kept neat and shall not be used for installation purposes. Upon completion of the final system drawings, a representative of the Government will review the final system work with the Contractor. If the final system work is not complete, the Contractor will be so advised and shall complete the work as required. Final drawings submitted with the endurance test report shall be finished drawings on mylar or vellum.

1.4 TESTING

1.4.1 General

The Contractor shall perform predelivery testing, site testing, and adjustment of the completed CCTV system. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing. Written notification of planned testing shall be given to the Government at least 14 days prior to the test, and in no case shall notice be given until after the Contractor has received written approval of the specific test procedures.

1.4.2 Test Procedures and Reports

Test procedures shall explain, in detail, step-by-step actions and expected results demonstrating compliance with the requirements of the specification. Test reports shall be used to document results of the tests. Reports shall be delivered to the Government within 7 days after completion of each test.

1.5 TRAINING

1.5.1 General

The Contractor shall conduct training courses for designated personnel in the maintenance and operation of the CCTV system as specified. The training shall be oriented to the specific system being installed under this contract. Training manuals shall be delivered for each trainee with two additional manuals delivered for archiving at the project site. The manuals shall include an agenda, defined objectives for each lesson, and a detailed description of the subject matter for each lesson. The Contractor is responsible for furnishing all audio-visual equipment and all other training materials and supplies. Where the Contractor presents portions of the course through the use of audio-visual material, copies of the audio-visual materials shall be delivered to the Government, either as a part of the printed training manuals or on the same media as that used during the training sessions. A training day is 8 hours of instruction, including two 15 minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the facility. For guidance in planning the required instruction, the Contractor should assume the attendees will have a high school education or equivalent. Approval of the planned training schedule shall be obtained from the Government at least 30 days prior to the training.

1.5.2 Operator's Training

The course shall be taught at the project site for five consecutive training days during or after the Contractor's field testing. A maximum of 12 personnel will attend the course. No part of the training given during this course will be counted toward completion of the performance verification test. The course shall consist of classroom instruction, hands-on training, instruction on the specific hardware configuration of the installed system, and specific instructions for operating the installed system. The course shall demonstrate system start up, system operation, system shutdown, system recovery after a failure, the specific hardware configuration, and operation of the system and its software. The students should have no unanswered questions regarding operation of the installed CCTV system. The Contractor shall prepare and insert additional training material in the training manuals when the need for additional material becomes apparent during instruction. The Contractor shall prepare a written report after the completion of the course. The Contractor shall list in the report the times, dates, attendees and material covered at each training session. The Contractor shall describe the skill level of each student at the end of this course. The Contractor shall submit the report before the end of the performance verification test. The course shall include:

a. General CCTV hardware, installed system architecture and configuration.

b. Functional operation of the installed system and software.

c. Operator commands.

d. Alarm interfaces.

e. Alarm reporting.

f. Fault diagnostics and correction.

g. General system maintenance.

h. Replacement of failed components and integration of replacement components into the operating CCTV system.

1.6 MAINTENANCE AND SERVICE

1.6.1 General Requirements

The Contractor shall provide all services required and equipment necessary to maintain the entire CCTV system in an operational state as specified for a period of 1 year after completion of the endurance test, and shall provide all necessary material required for the work. Impacts on facility operations shall be minimized when performing scheduled adjustments or other unscheduled work.

1.6.2 Description of Work

The adjustment and repair of the CCTV system includes all computer equipment, software updates, signal transmission equipment, and video equipment. Provide the manufacturer's required adjustments and all other work necessary.

1.6.3 Personnel

Service personnel shall be qualified to accomplish all work promptly and satisfactorily. The Government shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

1.6.4 Schedule of Work

The Contractor shall perform two inspections at 6-month intervals or less. This work shall be performed during regular working hours, Monday through Friday, excluding legal holidays. These inspections shall include:

a. Visual checks and operational tests of the CPU, switcher, peripheral equipment, interface panels, recording devices, monitors, video equipment electrical and mechanical controls, and a check of the picture quality from each camera.

b. Run system software and correct all diagnosed problems.

c. Resolve any previous outstanding problems.

1.6.5 Emergency Service

The Government will initiate service calls when the CCTV system is not functioning properly. Qualified personnel shall be available to provide service to the complete CCTV system. The Government shall be furnished with a telephone number where the service supervisor can be reached at all times. Service personnel shall be at the site within 24 hours after receiving a request for service. The CCTV system shall be restored to proper operating condition within 3 calendar days after receiving a request for service.

1.6.6 Operation

Performance of scheduled adjustments and repair shall verify operation of the CCTV system as demonstrated by the applicable portions of the performance verification test.

1.6.7 Records and Logs

The Contractor shall keep records and logs of each task, and shall organize cumulative records for each major component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain calibration, repair, and programming data. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the CCTV system.

1.6.8 Work Requests

The Contractor shall separately record each service call request, as received. The form shall include the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within 5 days after work is completed.

1.6.9 System Modifications

The Contractor shall make any recommendations for system modification in writing to the Government. No system modifications, including operating parameters and control settings, shall be made without prior approval of the Government. Any modifications made to the systems shall be incorporated into the operations and maintenance manuals, and other documentation affected.

1.6.10 Software

The Contractor shall recommend all software updates to the Government for approval. Upon Government approval, updates shall be accomplished in a timely manner, fully coordinated with the CCTV system operators, operation in the system verified, and shall be incorporated into the operations and maintenance manuals, and software documentation. There shall be at least one scheduled update near the end of the first year's warranty period, at which time the Contractor shall install and validate the latest released version of the manufacturer's software.

1.7 PAYMENT

No separate payment or direct payment will be made for the work covered under this section. Any such work shall be considered incidental to the applicable bid item to which the work pertains.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

All system hardware and software components shall be produced by manufacturers regularly engaged in the production of CCTV equipment. Units of the same type of equipment shall be products of a single manufacturer. All material and equipment shall be new and currently in production. Each major component of equipment shall have the manufacturer's name and address, and the model and serial number in a conspicuous place. Equipment located at the security center or a remote control/monitoring station shall be rack mounted as shown. Television equipment shall comply with 47 CFR 15, Subparts C and H. Computing devices shall comply with 47 CFR 15, Subpart J.

2.1.1 Fungus Treatment

System components located in fungus growth inductive environments shall be completely treated for fungus resistance. Treating materials containing a mercury bearing fungicide shall not be used. Treating materials shall not increase the flammability of the component or surface being treated. Treating materials shall not cause skin irritation or other injury to personnel handling it during fabrication, transportation, operation, maintenance, or during the use of the finished items when used for the purpose intended.

2.1.2 Soldering

All soldering shall be done in accordance with standard industry practices.

2.2 ENCLOSURES

The Contractor shall provide metallic enclosures as needed for equipment not housed in racks or supplied with a housing. The enclosures shall be as specified or shown.

2.2.1 Interior

Enclosures to house equipment in an interior environment shall meet the requirements of NEMA 250 Type 12.

2.2.2 Exposed-to-Weather

Enclosures to house equipment in an outdoor environment shall meet the requirements of NEMA 250 Type 4X.

2.2.3 Corrosion-Resistant

Enclosures to house equipment in a corrosive environment shall meet the requirements of NEMA 250 Type 4X.

2.2.4 Not Used

2.3 CONTROL RECEIVER DRIVER, OUTDOOR, PRESET POSITIONING

Outdoor fixed speed receiver, 120 VAC input, 120 VAC output for camera power and pan/tilt control. Product features shall include:

* Fixed Speed
* Pan/Tilt Control
* Lens Control (Zoom, Focus, Iris)
* Preset Positioning
* Camera and Pan/Tilt Power
* Open Collector Transistor Output for Manual Override of Automatic Iris Control

2.3.1 Technical Specifications

Electrical:

Input Volt.--------------------------120 VAC, 60 Hz
Output Volt. (Camera Pan/Tilt)--------120 VAC

Power Consumption:
Receiver--------------------------5 vA max.
Pan/Tilt Supply--------------------140 vA max.
Lens Supply-----------------------0-4 vA max.
Camera Supply----------------------15 vA Typ.

Connectors---------------------------BNC

Input Video Levels--------------------1 Vp-p nominal, 2 Vp-p max.

System Bandwith-----------------------Less than 2 dB down at 10 MHz

Fuse Protection-----------------------Yes

General:

Operating Temp.-----------------------(-4 to +140 F)
Housing-------------------------------NEMA 4X Environmental

2.4 Not Used
2.5 Not Used

2.6 Not Used
2.7 SOLID STATE CAMERA

2.7.1 High Resolution Color Camera

The video camera shall conform to EIA 170 and EIA ANSI/EIA-330 specifications. All electronic components and circuits shall be solid state. Signal-to-noise ratio shall not be less than 46 dB unweighted. The camera shall exhibit no geometric distortion. The lens mount shall be a C /CS-mount, and the camera shall have a back focus adjustment. The camera shall operate from 14 to 120 degrees F without auxiliary heating or cooling, and with no change in picture quality or resolution. The camera shall operate on 60 Hz AC power, and shall be capable of operating over a voltage range of 105 to 130 volts.

2.7.1.1 Solid State Image Array

The camera shall have a maximum format solid state imaging array, and the picture produced by the camera shall be free of blemishes as defined by EIA ANSI/EIA-330. The camera shall provide not less than 550 lines of horizontal resolution, and resolution shall not vary over the life of the camera.

2.7.1.2 Sensitivity

Camera shall provide full video output with the infrared cut-off filter installed, without camera automatic gain, and a scene reflectivity of 75 percent using an f/1.2 lens giving a camera faceplate illumination at 2850K of 0.15 footcandle.

2.7.1.3 Camera Synchronization

The camera shall have an input for external sync, and shall automatically switch over to internal sync if external sync is not present. The camera shall also have the capability of synchronization by line-locking to the AC power 60 Hz line frequency at the zero crossing point, and shall provide not less than plus or minus 90 degrees of vertical phase adjustment.

2.7.1.4 Connectors

Cameras with lenses having auto iris, manual iris, or zoom and focus functions shall be supplied with connectors and wiring as needed to operate the lens functions. Video signal output connector shall be a BNC. Cameras with integral fiber optic video transmitters shall have straight-tip bayonet type fiber optic video output connectors. A connector shall be provided for external sync input.

2.7.1.5 Not Used

2.7.2 Not Used

2.8 CAMERA LENSES

Camera lenses shall be all glass with coated optics. The lens mount shall be a C/CS-mount. The lens shall be supplied with the camera, and shall have a maximum f-stop opening of f/1.4 or the maximum available for the focal length specified. The lens shall be equipped with an auto-iris mechanism unless otherwise specified. Lenses having auto iris, manual iris, or zoom and focus functions shall be supplied with connectors, wiring, receiver/drivers, and controls as needed to operate the lens functions. Lenses shall have sufficient circle of illumination to cover the image sensor evenly. Lenses shall not be used on a camera with an image format larger than the lens is designed to cover. Lens focal lengths shall be as shown or specified in the lens table.

2.9 CAMERA HOUSING

2.9.1 Environmentally Sealed Camera Housing

The housing shall be designed to provide a condensation free environment for camera operation. The housing shall be constructed to be dust and water tight, and fully operational in 100 percent condensing humidity. The housing shall be purged of atmospheric air and pressurized with dry nitrogen, shall be equipped with a fill valve, overpressure valve, and shall have a humidity indicator visible from the exterior. Housing shall not have a leak rate greater than 2 pounds per square inch at sea level within a 90 day period. The housing shall be equipped with supplementary camera mounting blocks or supports as needed to position the specified camera and lens to maintain the proper optical centerline. All electrical and signal connections required for operation of the camera and lens shall be supplied. The housing shall provide the environment needed for camera operation, and shall keep the viewing window free of fog, snow, and ice. The housing shall be equipped with a sunshield, and both the housing and the sunshield shall be white. A mounting bracket which can be adjusted to center the weight of the housing and camera assembly shall be provided as part of the housing.

2.9.2 Not Used

2.10 COLOR VIDEO MONITOR

The 12 monitors shall conform to EIA 170, EIA ANSI/EIA-375-A-1976, and UL 1410specifications. All electronic components and circuits shall be solid state except for the picture tube. The monitor shall operate on 120 volts 60 Hz AC power, shall have a stabilized high voltage power supply, and regulated low voltage power supplies. The monitor shall have automatic frequency control (AFC), bandwidth greater than 7 MHz, and horizontal resolution not less than 460 lines at the center of the picture tube. The monitor shall be capable of reproducing a minimum of 10 discernable shades of gray as described in EIA ANSI/EIA-375-A-1976. The video input shall accept composite video with switchable loop-through or 75 ohm termination.

2.10.1 Picture Tube

The monitor shall have a 14 in. inchpicture tube measured diagonally.

2.10.2 Configuration

The monitor shall be configured in a standard table top mount with swivel base. Monitors shall not interfere with each other when rack mounted or operated next to each other as described in EIA ANSI/EIA-375-A-1976.

2.10.3 Controls

Front panel controls shall be provided for power on/off, horizontal hold, vertical hold, contrast, and brightness. The monitor shall have switchable DC restoration.

2.10.4 Connectors for Video Monitor

Video signal input and output shall be by BNC connectors.

2.11 VIDEO MATRIX SWITCHER (Total of 2)

The switchers shall conform to EIA 170 specifications, and shall be vertical interval switchers. Electronic components, subassemblies, and circuits of the switcher shall be solid state. Each switcher shall be microprocessor based and software programmable. Each switcher shall be a modular system that shall allow for expansion or modification of inputs, outputs, alarm interfaces, and secondary control stations by addition of the appropriate modules. Switcher components shall operate on 120 volts 60 Hz AC power. Each switcher central processor unit shall be capable of being interfaced to a master security computer for integrated operation and control. The video switcher central processing unit (CPU) shall have the capability of accepting time from a master clock supplied in ASCII format through an EIA ANSI/EIA/TIA-232-F input. All components, modules, cables, power supplies, software, and other items needed for a complete and operable CCTV switching system shall be provided. Switcher equipment shall be rack mounted unless otherwise specified. Rack mount hardware shall be supplied to mount the switcher components in a standard 19 inch rack as described in EIA ANSI/EIA-310-D.

2.11.1 Switcher Software

The switcher shall be software programmable, and the software shall be supplied as part of the switcher. The software shall be installed in the switcher CPU, and shall be configured as required by the site design. Changes or alterations of features under software control shall be accomplished through software programming without changes in hardware or system configuration. The switcher shall retain the current program for at least 4 hours in the event of power loss, and shall not require reprogramming in order to restart the system.

2.11.2 Switcher Matrix

Each switcher shall be a programmable crosspoint switcher capable of switching any video input to any video output. Each switcher to be installed at the site shall be configured to switch 20 cameras to 12 monitors, and shall have an expansion capability of not less than 40 percent.

2.11.3 Not Used

2.11.4 Not Used

2.11.5 Control Keyboards

Control and programming keyboards shall be supplied for the video switchers at the main control console, the existing Upper Control Station, the Maintenance Shop Dam PLC Room,, and control keyboards shall be supplied for any control/monitoring stations as shown. The control keyboard shall provide the interface between the operator and the CCTV system, and shall relay commands from the operator to the switcher CPU. The keyboard shall provide control of the video switcher functions needed for operation and programming of the video switcher. Controls shall include, but not be limited to: programming the switcher, switcher control, lens function control, pan/tilt/zoom (PTZ) control, control of environmental housing accessories, and annotation programming. If the switcher CPU requires an additional text keyboard for system management functions, the keyboard shall be supplied as part of the video switcher.

2.11.6 Accessory Control Equipment

The video switcher shall be equipped with signal distribution units, preposition cards, expansion units, cables, software or any other equipment needed to ensure that the CCTV systems is complete and fully operational.

2.11.7 Connectors for Video Switcher

Video signal input and output shall be by BNC connectors.

2.11.8 Video Annotation

Video annotation equipment shall be provided for the video switcher. The annotation shall be alphanumeric and programmable for each video source. Annotation to be generated shall include, but not be limited to: individual video source identification number, time (hour, minute, second) in a 24 hour format, date (month, day, year), and a unique, user-defined title with at least 8 characters. The annotation shall be inserted onto the source video so that both shall appear on a monitor or recording. The lines of annotation shall be movable for horizontal and vertical placement on the video picture. The annotation shall be automatically adjusted for date. Programmed annotation information shall be retained in memory for at least 4 hours in the event of power loss.

***2, *3**

2.12 DIGITAL VIDEO RECORDER

The digital video recorders shall be a multi-channel record and playback system with the capability of monochrome and color real time multi-screen viewing. Electronic components, sub assemblies, and circuits of the multiplexer shall be solid state. The digital recorder shall permit up to 16 camera inputs to be recorded simultaneously. All 16 camera inputs shall be capable of being viewed on a video monitor either live or recorded. . The inputs shall be capable of simultaneous viewing on the monitor or full screen individually and in other multi-screen modes such as 2x2, 3x3, 4x4 or other configurations. The viewing format shall also permit 2x dynamic zoom capability, full screen. The recorder shall also include the following functions:

* **Multiple hard drive configuration for video storage with a minimum of 180 GB video storage capacity, each.**

* Multiple camera displays for live viewing or playback while recording continuos motion detection, alarm, pre-alarm, and scheduled recording modes

* Record upto 60 images per second

* High speed search

* Play back by date, time, and camera

* Up to 8 alarm inputs

* Up to 8 output controls
* Built-in video motion detection
* Hardware Watchdog
* On screen programming and operation

***2,*3**

2.13 Not Used

2.14 Not Used

2.15 CAMERA SUPPORT EQUIPMENT

The camera and lens contained in a camera housing shall be installed on a camera support as shown. Any ancillary mounting hardware needed to install the support and to install the camera on the support shall be provided as part of the support. The camera support shall be capable of supporting the equipment to be mounted on it including wind and ice loading normally encountered at the site.

2.15.1 Not Used

2.15.2 Not Used

2.15.3 Pan/Tilt Mounting Pole

The pan/tilt mounting pole shall be a straight steel or aluminum pole. The pole shall be 5 feet high and shall have a mounting plate at the top for the pan/tilt. The pole and mounting plate shall have a corrosion-resistant finish. The mounting plate shall have a bolt hole pattern to match the base of the pan/tilt to be mounted on the pole. Under maximum loading, the total pole deflection shall not exceed 0.1 of one degree. A cable conduit shall be provided from the base of the pole to the mounting plate of the pan/tilt. The conduit shall be sized to accommodate all wiring needed for the camera and pan/tilt.

2.15.4 NOT USED

2.15.5 Pan/Tilt Mount

The pan/tilt mount shall be capable of supporting the camera, lens and housing specified. If the pan/tilt is to be mounted outdoors, the pan/tilt shall be weatherproof, and sized to accommodate the camera, lens and housing weight plus maximum wind loading encountered at the installation site. The pan/tilt shall have heavy duty bearings, hardened steel gears, externally adjustable limit stops for pan and tilt, and mechanical, dynamic or friction brakes. Pan/tilt shall be permanently lubricated. The motors shall be thermally or impedance protected against overload damage. Pan movement shall not be less than 0 to 350 degrees, tilt movement shall not be less than plus and minus 90 degrees. Pan speed shall not be less than 6 degrees per second, and tilt speed shall not be less than 3 degrees per second. The pan/tilt shall be supplied complete with wiring, wiring harnesses, connectors, receiver/driver, pan/tilt control system, pre-position cards, or any other hardware and equipment as needed to provide a fully functional pan/tilt mount to fulfill the site design requirements.

2.16 ACCESSORIES

Standard 19 inch electronic rack cabinets conforming to EIA ANSI/EIA-310-D shall be provided for the CCTV system at the remote control/monitoring sites as shown.

2.16.1 Spare Parts

The following equipment shall be provided as spare components of the system specified herein:

1. Two high-resolution color cameras
2. Two sets of motorized zoom lenses
   One 10x, 8-80mm
   One 15x, 8-120mm
3. Two fiber optic video transceivers, Transceivers specified in Spec. 16768.
4. One PTZ keyboard controller
5. Two Pan/Tilt/Zoom receiver drivers in weather proof enclosure

2.17 WIRE AND CABLE

The Contractor shall provide all wire and cable not indicated as Government Furnished Equipment. All wire and cable components shall be able to withstand the environment the wire or cable is installed in for a minimum of 20 years.

2.17.1 CCTV Equipment Video Signal Wiring

The coaxial cable shall have a characteristic impedance of 75 ohms plus or minus 3 ohms. RG 59/U coaxial signal cable shall have shielding which provides a minimum of 95 percent coverage, a solid copper center conductor of not less than 23 AWG, polyethylene insulation, and a black non-contaminating polyvinylchloride (PVC) jacket. RG 6/U coaxial cable shall have shielding which provides a minimum of 95 percent coverage, with center conductor of 18 AWG or larger polyethylene insulation, and a black non-contaminating polyvinylchloride (PVC) jacket.

2.17.2 Not Used

2.17.3 Not Used

2.18 PREDELIVERY TESTING

2.18.1 General

The Contractor shall assemble the test CCTV system as specified, and perform tests to demonstrate that the performance of the system complies with the contract requirements in accordance with the approved predelivery test procedures. The tests shall take place during regular daytime working hours on weekdays. Model numbers of equipment tested shall be identical to those to be delivered to the site. Original copies of all data produced during predelivery testing, including results of each test procedure, shall be delivered to the Government at the conclusion of predelivery testing prior to Government approval of the test. The test report shall be arranged so that all commands, stimuli, and responses are correlated to allow logical interpretation.

2.18.2 Test Setup

The Contractor shall provide the equipment needed for the test setup and shall configure it to provide alarm actuated camera call-up and alarm recording as required to emulate the installed system. The test setup shall consist of at least 4 complete camera circuits. The alarm signal input to the CCTV test setup shall be by the same method that is used in the installed system. The video switcher shall be capable of switching any camera to any monitor and any combination of cameras to any combination of monitors. The minimum test setup shall include:

a. Four video cameras and lenses.

b. Three video monitors.

c. Video recorder if it is required for the installed system.

d. Video switcher including video input modules, video output modules, and control and applications software.

e. Alarm input panel if required for the installed system.

f. Pan/tilt mount and pan/tilt controller if the installed system includes cameras on pan/tilt mounts.

g. Any ancillary equipment associated with a camera circuit such as equalizing amplifiers, video loss/presence detectors, terminators, ground loop correctors, surge protectors or other in-line video devices.

h. Cabling for all components.

PART 3 EXECUTION

3.1 INSTALLATION

The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2 and as shown, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system. All interior wiring, including low voltage wiring outside the security center control console and equipment racks, cabinets, boxes and similar enclosures, shall be installed in rigid, galvanized steel conduit conforming to UL 6. Interconnection wiring between components mounted in the same rack or cabinet does not need to be installed in conduits. Minimum conduit size shall be 1/2 inch. Connections shall be tight tapered threaded. No threadless fittings or couplings shall be used. Conduit enclosures shall be cast metal or malleable iron as specified in Section(s) 16415 with threaded hubs or bodies. Electric metallic tubing (EMT), armored cable, nonmetallic sheathed cables, or flexible conduit will not be permitted except where specifically shown. DTM shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other building wiring. Flexible cords or cord connections shall not be used to supply power to any components of the CCTV system, except where specifically shown. All other electrical work shall be as specified in Section 16120 & 16415 and as shown. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

3.1.1 Current Site Conditions

The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Government in a report as defined in paragraph Group II Technical Data Package. The Contractor shall not take any corrective action without written permission from the Government.

3.1.2 Existing Equipment

The Contractor shall connect to existing video equipment, video and control signal transmission lines, and devices as shown. Video equipment and signal lines that are usable in their original configuration without modification may be reused with Government approval. The Contractor shall perform a field survey, including testing and inspection of all existing video equipment and signal lines intended to be incorporated into the CCTV system, and furnish a report to the Government as part of the site survey report as defined in paragraph "Group II Technical Data Package." For those items considered nonfunctioning, provide (with the report) specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, the Contractor shall include the scheduled need date for connection to all existing equipment. The Contractor shall make written requests and obtain approval prior to disconnecting any signal lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Government approval of these requests. If any device fails after the Contractor has commenced work on that device, signal or control line, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment. The Government is responsible for maintenance and repair of Government equipment. The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of Government equipment.

3.1.3 Enclosure Penetrations

All enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in such a manner that the cable is not damaged.

3.1.4 Not Used

3.1.5 Interconnection of Console Video Equipment

The Contractor shall connect signal paths between video equipment of 25 feet or less with RG-59/U coaxial cable and signal paths between equipment longer than 25 feet with RG-6/U coaxial cable. Cables shall be as short as practicable for each signal path without causing strain at the connectors. Rack mounted equipment on slide mounts shall have cables of sufficient length to allow full extension of the slide rails from the rack.

3.1.6 Cameras

The Contractor shall install the cameras with the proper focal length lens as indicated for each zone; connect power and signal lines to the camera; set cameras with fixed iris lenses to the proper f-stop to give full video level; aim camera to give field of view as needed to cover the alarm zone; aim fixed mount cameras installed outdoors facing the rising or setting sun sufficiently below the horizon to preclude the camera looking directly at the sun; focus the lens to give a sharp picture over the entire field of view; and synchronize all cameras so the picture does not roll on the monitor when cameras are selected.

3.1.7 Monitors

The Contractor shall install the monitors as shown and specified; connect all signal inputs and outputs as shown and specified; terminate video input signals as required; and connect the monitor to AC power.

3.1.8 Switchers

The Contractor shall install the switchers as shown and according to manufacturer's instructions; connect all subassemblies as specified by the manufacturer and as shown; connect video signal inputs and outputs as shown and specified; terminate video inputs as required; connect alarm signal inputs and outputs as shown and specified; connect control signal inputs and outputs for ancillary equipment or secondary control/monitoring sites as specified by the manufacturer and as shown; connect the switcher CPU and switcher subassemblies to AC power; load all software as specified and required for an operational CCTV system configured for the site requirements, including data bases, operational parameters, and system, command, and application programs; provide the original and 2 backup copies for all accepted software upon successful completion of the endurance test; and program the video annotation for each camera.

3.1.9 Video Recording Equipment

The Contractor shall install the video recording equipment as shown and as specified by the manufacturer; connect video signal inputs and outputs as shown and specified; connect alarm signal inputs and outputs as shown and specified; and connect video recording equipment to AC power.

3.1.10 Not Used

3.1.11 Camera Mount

The Contractor shall: install the camera mount as specified by the manufacturer and as shown; provide mounting hardware sized appropriately to secure the mount, camera and housing with maximum wind and ice loading encountered at the site; provide a foundation for each camera pole as specified and shown; provide a ground rod for each camera pole and connect the camera pole to the ground rod as specified in Section 16415; provide electrical and signal transmission cabling to the mount location as specified in Section 16415 and 16768; connect signal lines and AC power to mount interfaces; connect pole wiring harness to camera.

3.1.12 Pan/Tilt Mount

The Contractor shall install pan/tilt mount, receiver/driver and mount appurtenances as specified by the manufacturer and as shown; supply mounting hardware sized appropriately to secure pan/tilt, camera and housing with maximum wind and ice loading encountered at the site; install pan/tilt control wiring as specified in Section 16415 and as shown; and connect pan/tilt to control wiring and AC power.

3.2 SYSTEM STARTUP

The Contractor shall not apply power to the CCTV systems, Main, Satellite, and Remote, until the following items have been completed:

a. CCTV system equipment items and DTM have been set up in accordance with manufacturer's instructions.

b. A visual inspection of the CCTV system has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.

c. System wiring has been tested and verified as correctly connected as indicated.

d. All system grounding and transient protection systems have been verified as properly installed and connected as indicated.

e. Power supplies to be connected to the CCTV system have been verified as the correct voltage, phasing, and frequency as indicated.

f. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work/equipment.

3.3 Not Used

3.4 SITE TESTING

3.4.1 General

The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all site testing. The Government will witness all performance verification and endurance testing. Written permission shall be obtained from the Government before proceeding with the next phase of testing. Original copies of all data produced during performance verification and endurance testing shall be turned over to the Government at the conclusion of each phase of testing prior to Government approval of the test.

3.4.2 Contractor's Field Testing

The Contractor shall calibrate and test all equipment, verify DTM operation, place the integrated systems in service, and test the integrated systems. Ground rods installed by the Contractor shall be tested as specified in IEEE Std 142. The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure. In addition, the Contractor shall make a master video tape recording showing typical day and night views of each camera in the system and shall deliver the tape with the report. Note any objects in the field of view that might produce highlights that could cause camera blinding. Note any objects in the field of view or anomalies in the terrain which may cause blind spots. Note if a camera cannot be aimed to cover the zone and exclude the rising or setting sun from the picture. Note night assessment capabilities and whether lights or vehicle headlights cause blooming or picture degradation. If any of the above conditions or other conditions exist that cause picture degradation or interfere with the camera field of view, the Contractor shall inform the Contracting Officer. The tape shall be recorded using the video recorder installed as part of the CCTV system. If a recorder is not part of the CCTV system, the Contractor shall provide the tape in Video Home System (VHS) format. The Contractor shall provide the Government with the original tape as part of the documentation of the system and shall submit a letter certifying that the CCTV system is ready for performance verification testing. The field testing shall as a minimum include:

a. Verification that the video transmission system and any signal or control cabling have been installed, tested, and approved as specified under this Section .

b. When the system includes remote control/monitoring stations or remote switch panels, verification that the remote devices are functional, communicate with the security center, and perform all functions as specified.

c. Verification that the switchers are fully functional and that the switcher software has been programmed as needed for the site configuration.

d. Verification that switcher software is functioning correctly. All software functions shall be exercised.

e. Operation of all electrical and mechanical switcher controls and verification that the control performs the designed function.

f. Verification that all video sources and video outputs provide a full bandwidth signal that complies with EIA 170 at all video inputs.

g. Verification that all video signals are terminated properly.

h. Verification that all cameras are aimed and focused properly. The Contractor shall conduct a walk test of the area covered by each camera to verify the field of view.

i. Verification that cameras facing the direction of rising or setting sun are aimed sufficiently below the horizon so that the camera does not view the sun directly.

j. If vehicles are used in proximity of the assessment areas, verification of night assessment capabilities and determination if headlights cause blooming or picture degradation.

k. Verification that all cameras are synchronized and that the picture does not roll when cameras are switched.

l. Verification that the alarm interface to the IDS is functional and that automatic camera call-up is functional for all designated IDS or EECS alarm points and cameras.

m. When pan/tilt mounts are used in the system, verification that the limit stops have been set correctly. Verification of all controls for pan/tilt or zoom mechanisms are operative and that the controls perform the desired function. If preposition controls are used, verification that all home positions have been set correctly, and have been tested for auto home function and correct home position.

The Contractor shall deliver a report describing results of functional tests, diagnostics, and calibrations including written certification to the Government that the installed complete system has been calibrated, tested, and is ready to begin performance verification testing. The report shall also include a copy of the approved performance verification test procedure.

3.4.3 Performance Verification Test

The Contractor shall demonstrate that the completed CCTV systems, Main, Satellite, and Remote comply with the contract requirements. Using approved test procedures, all physical and functional requirements of the project shall be demonstrated and shown. The performance verification test, as specified, shall not be started until receipt by the Contractor of written permission from the Government, based on the Contractor's written report. This shall include certification of successful completion of Contractor Field Testing as specified in paragraph "Contractor's Field Testing," and upon successful completion of training as specified. The Government may terminate testing at any time when the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Endurance Testing Phase II. Upon successful completion of the performance verification test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to commencing the endurance test.

3.4.4 Endurance Test

a. The Contractor shall demonstrate the specified requirements of the completed systems. The endurance test shall be conducted in phases as specified. The endurance test shall not be started until the Government notifies the Contractor, in writing, that the performance verification test is satisfactorily completed, training as specified has been completed, and correction of all outstanding deficiencies has been satisfactorily completed. The Government may terminate testing at any time the system fails to perform as specified. Upon termination of testing by the Government or by the Contractor, the Contractor shall commence an assessment period as described for Phase II. During the last day of the test the Contractor shall verify the operation of each camera. Upon successful completion of the endurance test, the Contractor shall deliver test reports and other documentation as specified to the Government prior to acceptance of the system.

b. Phase I (Testing): The test shall be conducted 24 hours per day for 7 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing. If the system experiences no failures during Phase I testing, the Contractor may proceed directly to Phase III testing after receipt by the Contractor of written permission from the Government.

c. Phase II (Assessment): After the conclusion of Phase I, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. Based on the Contractor's report , the Government will determine the restart date, or may require that Phase I be repeated. If the retest is completed without any failures, the Contractor may proceed directly to Phase III testing after receipt by the Contractor of written permission from the Government.

d. Phase III (Testing): The test shall be conducted 24 hours per day for 7 consecutive calendar days, including holidays, and the system shall operate as specified. The Contractor shall make no repairs during this phase of testing unless authorized by the Government in writing.

e. Phase IV (Assessment): After the conclusion of Phase III, the Contractor shall identify all failures, determine causes of all failures, repair all failures, and deliver a written report to the

Government. The report shall explain in detail the nature of each failure, corrective action taken, results of tests performed, and shall recommend the point at which testing should be resumed. Based on the Contractor's report , the Government will determine the restart date, and may require that Phase III be repeated. The Contractor shall not commence any required retesting until after receipt of written notification by Government. After the conclusion of any retesting which the Government may require, the Phase IV assessment shall be repeated as if Phase III had just been completed.

f. Exclusions: The Contractor will not be held responsible for failures resulting from the following:

(1) An outage of the main power supply in excess of the capability of any backup power source, provided that the automatic initiation of all backup sources was accomplished.

(2) Failure of existing Government owned equipment, provided that the failure was not due to Contractor furnished equipment, installation, or software.

-- End of Section --

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DIVISION 15 - MECHANICAL

SECTION 15768

ELECTRIC SPACE HEATING EQUIPMENT

05/02

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SECTION 15768

ELECTRIC SPACE HEATING EQUIPMENT
05/02

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1025	(1980; R 1990, Bul. 1991) Electric Air Heaters

1.2 GENERAL REQUIREMENTS

Section 16415, ELECTRICAL WORK, INTERIOR applies to this section, with the additions and modifications specified herein.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01335 SUBMITTAL PROCEDURES:

SD-01 Data

Electric unit heaters; GA, ED.

SD-04 Shop Drawings

Heater installation drawing; GA, RE.

SD-19 Operation and Maintenance Data

Electric unit heaters; GA, ED.

Submit operation and maintenance data in accordance with Section 01800, SYSTEM OPERATING, MAINTENANCE, AND REPAIR MANUALS.

PART 2 PRODUCTS

2.1 ELECTRIC UNIT HEATERS

UL 1025; wattage, voltage, Btu/hrand CFM as indicated in the mechanical equipment schedules. Provide control-circuit terminals and single source of power supply. Heaters shall be 3-phase, with load balanced on each of the three phases. Limit leaving air temperature to 140 degrees F with entering air of 60 degrees F. Unit heaters shall suspend from overhead such that air flow from the unit heater shall discharge in a downward vertical direction.

2.1.1 Heating Element

Nickel chromium heating wire element, free from expansion noise and 60 Hz hum. Embed element in magnesium-oxide insulating refractory. Seal element in high-mass steel or corrosion-resisting metallic sheath with fins. Enclose element ends in terminal box. Provide not more than six fins per inch. Limit fin surface temperature 550 degrees F at any point during normal operation.

2.1.2 Controls

Include limit controls for overheat protection of heaters. For remote thermostatic operation, provide contactor rated for 100,000 duty cycles. Provide a control transformer to supply 120-volt thermostat control circuit for each heater.

2.1.3 Wiring

Completely factory-prewired to terminal strips, ready to receive branch circuit and control connections for 140 degrees Fcopper or aluminum wiring.

2.1.4 Disconnect Means

Provide factory-installed safety disconnect switch in the housing or in an auxiliary matching control section with "off" position marking on the face plate.

2.2 DISCONNECTS

Disconnect. UL listed. NEMA Type 1 enclosure. Disconnect shall be capable of being locked in the open position.

PART 3 EXECUTION

3.1 INSTALLATION

Install in conformance with the approved heater installation drawing, NFPA 70, UL listing, and manufacturer's instructions, with necessary clearances for air circulation, maintenance, inspection, service testing and repair. Connect to electrical supply in accordance with Section 16415, ELECTRICAL WORK, INTERIOR

3.1.1 Unit Heaters

Mount units plumb, square and level with ceiling and walls.

3.2 FIELD QUALITY CONTROL

Provide necessary personnel, instruments, and equipment to perform tests. Notify the Contracting Officer 5 working days prior to scheduled testings and locations.

3.2.1 Field Inspection

Prior to initial operation, inspect installed equipment for conformance with drawings and specifications.

3.2.2 Insulation Resistance Tests

Test 600-volt wiring to verify that no short circuits or grounds exist. Tests shall be made using an instrument which applies a voltage of approximately 500 volts and provides a direct reading of resistance in ohms.

3.2.3 Operational Tests

Test equipment circuits and devices to demonstrate proper operation.Test each item of control equipment not less than 5 times.

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DIVISION 16 - ELECTRICAL

SECTION 16710

PREMISES DISTRIBUTION SYSTEM

04/97

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SECTION 16710

PREMISES DISTRIBUTION SYSTEM
04/97

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

ANSI/TIA/EIA-568-A	(1995) Commercial Building Telecommunications Cabling Standard
ANSI/TIA/EIA-568-A-5	(2000) Transmission Performance Specifications for 4-pair 100 ohm Category 5E Cabling
ANSI/TIA/EIA-569-A	(1998) Commercial Building Standard for Telecommunications Pathways and Spaces
ANSI/TIA/EIA-606	(1993) Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
ANSI/TIA/EIA-607	(1994) Commercial Building Grounding and Bonding Requirements for Telecommunications
TIA/EIA TSB 67	(1995) Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems

IBM CORPORATION (IBM)

IBM GA27-3361-07	(1987) LAN Cabling System - Planning and Installation
IBM GA27-3773-0	(1987) Cabling System Technical Interface Specifications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

UNDERWRITERS LABORATORY (UL)

UL 50	(1995; Rev thru Nov 1999) Enclosures for Electrical Equipment

1.2 SYSTEM DESCRIPTION

The premises distribution system shall consist of inside-plant horizontal, riser, and backbone cables and connecting hardware to transport telephone and data (including LAN) signals between equipment items in a building.

1.3 ENVIRONMENTAL REQUIREMENTS

Connecting hardware shall be rated for operation under ambient conditions of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, noncondensing.

1.4 QUALIFICATIONS

1.4.1 Minimum Contractor Qualifications

All work under this section shall be performed by and all equipment shall be furnished and installed by a certified Telecommunications Contractor, hereafter referred to as the Contractor. The Contractor shall have the following qualifications in Telecommunications Systems installation:

a. Contractor shall have a minimum of 3 years experience in the application, installation and testing of the specified systems and equipment.

b. Not Used

c. All installers assigned to the installation of this system or any of its components shall have a minimum of 3 years experience in the installation of the specified copper and fiber optic cable and components.

1.4.2 Minimum Manufacturer Qualifications

The equipment and hardware provided under this contract will be from manufacturers that have a minimum of 3 years experience in producing the types of systems and equipment specified.

1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. When used, a designation following the "GA" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts; GA, ED.

Lists of spare parts, tools, and test equipment for each different item of material and equipment specified, after approval of detail drawings, not later than 2 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

SD-04 Drawings

Premises Distribution System; GA, ED.

Detail drawings including a complete list of equipment and material. Detail drawings shall contain complete wiring and schematic diagrams and other details required to demonstrate that the system has been coordinated and will function properly as a system. Drawings shall include vertical riser diagrams, equipment rack details, elevation drawings of telecommunications closet walls, outlet face plate details for all outlet configurations, sizes and types of all cables, conduits, and cable trays. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation.

Record Drawings; GA, RE.

Record drawings for the installed wiring system infrastructure per ANSI/TIA/EIA-606. The drawings shall show the location of all cable terminations and location and routing of all backbone and horizontal cables. The identifier for each termination and cable shall appear on the drawings.

SD-06 Instructions

Manufacturer's Recommendations; GA, ED.

Where installation procedures, or any part thereof, are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations, prior to installation shall be provided. Installation of the item will not be allowed to proceed until the recommendations are received and approved.

SD-08 Statements

Test Plan; GA, RE.

Test plan defining the tests required to ensure that the system meets technical, operational and performance specifications, 60 days prior to the proposed test date. The test plan must be approved before the start of any testing. The test plan shall identify the capabilities and functions to be tested, and include detailed instructions for the setup and execution of each test and procedures for evaluation and documentation of the results.

Qualifications; GA, RE.

The qualifications of the Manufacturer, Contractor, and the Installer to perform the work specified herein. This shall include proof of the minimum qualifications specified herein.

SD-09 Reports

Test Reports; GA, ED.

Test reports in booklet form with witness signatures verifying execution of tests. Reports shall show the field tests performed to verify compliance with the specified performance criteria. Test reports shall include record of the physical parameters verified during testing. Test reports shall be submitted within 7 days after completion of testing.

SD-13 Certificates

Premises Distribution System; FIO, RE.

Written certification that the premises distribution system complies with the ANSI/TIA/EIA-568-A, ANSI/TIA/EIA-569-A, and ANSI/TIA/EIA-606 standards.

Materials and Equipment; FIO, RE.

Where materials or equipment are specified to conform, be constructed or tested to meet specific requirements, certification that the items provided conform to such requirements. Certification by a nationally recognized testing laboratory that a representative sample has been tested to meet the requirements, or a published catalog specification statement to the effect that the item meets the referenced standard, will be acceptable as evidence that the item conforms. Compliance with these requirements does not relieve the Contractor from compliance with other requirements of the specifications.

Installers; GA, RE.

The Contractor shall submit certification that all the installers are factory certified to install and test the provided products.

SD-18 Records

Record Keeping and Documentation; GA, RE.

Documentation on cables and termination hardware in accordance with ANSI/TIA/EIA-606.

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust or other contaminants.

1.7 OPERATION AND MAINTENANCE MANUALS

Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance for all products provided as a part of the premises distribution system. Specification sheets for all cable, connectors, and other equipment shall be provided.

1.8 NOT USED

1.8.1 [Enter Appropriate Subpart Title Here]PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least 1 year prior to installation. Materials and equipment shall conform to the respective publications and other requirements specified below and to the applicable requirements of NFPA 70.

2.2 NOT USED

2.3 SHIELDED TWISTED PAIR CABLE SYSTEM

2.3.1 Backbone Cable

Backbone cable shall meet the requirements of IBM GA27-3773-0 for 150 ohm Shielded Twisted Pair Cable and shall meet or exceed IBM performance requirements for Type 1A cable. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.

2.3.2 Horizontal Cable

Horizontal cable shall meet the requirements of IBM GA27-3773-0 for 150 ohm Shielded Twisted Pair Cable and shall meet or exceed IBM performance requirements for Type 1A cable. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.

2.3.3 Connecting Hardware

2.3.3.1 Connectors

Connectors for shielded twisted pair cable shall meet the requirements of ANSI/TIA/EIA-568-A for media interface connectors and IBM GA27-3773-0 for Type 1A data connectors. Connectors shall be of hermaphroditic design and shall be utilized for outlets and patch panel terminations. Outlet faceplates shall be provided and shall be stainless steel .

2.3.3.2 Patch Panels

Patch panels shall be 19 inch rack mounted panels with openings for shielded twisted pair connectors. Panels shall be metallic and shall ground the outer shield of the cable . Patch panels shall provide strain relief for cables. Panels shall be labeled with alphanumeric x-y coordinates .

2.3.3.3 Patch Cords

Patch cords shall be cable assemblies consisting of flexible shielded twisted pair cable with shielded twisted pair type connectors at each end. Cable shall meet the requirements of IBM GA27-3773-0 for 150 ohm Shielded Twisted Pair Cable and shall meet or exceed performance requirements for Type 6A patch panel data cable. Connectors shall meet or exceed the requirements of ANSI/TIA/EIA-568-A for media interface connectors. Patch cords shall be factory assembled.

2.4 NOT USED

2.5 NOT USED

2.6 EQUIPMENT RACKS

2.6.1 Floor Mounted Open Frame

Floor mounted equipment racks shall be welded steel relay racks with uprights to mount equipment 19 inches wide. Uprights shall be 3 inch deep channel, 1-1/4 inches wide, drilled and tapped 12-24 in a 1/2 inch pattern. Racks shall be provided with a standard top crossmember, and predrilled base plate to allow floor fastening. AC outlets shall be provided as shown.

2.6.2 Wall Mounted Open Frame

Wall mounted open frame equipment racks shall be steel relay racks to mount equipment 19 inches wide with standoff brackets for wall mounting. Uprights shall be drilled and tapped 12-24 in a 1/2 inch pattern. Standoff brackets shall be of sufficient length for a 6 inch clearance between rack and wall. Wall mounted open frame racks shall be hinged. AC outlets shall be provided as shown.

2.6.3 Cable Guides

Cable guides shall be specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on 19 inch equipment racks. Cable guides shall consist of ring or bracket-like devices mounted on rack panels for horizontal use or individually mounted for vertical use. Cable guides shall mount to racks by screws and/or nuts and lockwashers.

2.6.4 Floor Mounted Cabinets

Equipment cabinets shall be floor mounted enclosures with side panels, acrylic plastic front doors, rear louvered metal doors, depth-adjustable front and rear mounting rails, and louvered top. Ventilation fans will not be included. Vertical cable management devices shall be integral to the cabinet. Equipment racks shall mount equipment 19 inches wide and shall be 72 inches high and 30 inches deep. Cabinet exteriors shall be painted ivory/off-white .

2.6.5 Wall Mounted Cabinets

Wall mounted cabinets shall conform to UL 50 and have boxes constructed of zinc-coated sheet steel with dimensions not less than shown on drawings. Trim shall be fitted with hinged door and flush catch. Doors shall provide maximum openings to the box interiors. Boxes shall be provided with 3/4 inch plywood backboard painted white or a light color. A duplex AC outlet shall be installed within the cabinet.

2.7 EQUIPMENT MOUNTING BACKBOARD

Plywood backboards shall be provided, sized as shown, painted with white or light colored paint.

2.8 TELECOMMUNICATIONS OUTLET BOXES

Electrical boxes for telecommunication outlets shall be 4-11/16 inch square by 2-1/8 inches deep with minimum 3/8 inch deep single or two gang plaster ring as shown. Provide a minimum 1 inch conduit.

PART 3 EXECUTION

3.1 INSTALLATION

System components and appurtenances shall be installed in accordance with NFPA 70, manufacturer's instructions and as shown. Necessary interconnections, services, and adjustments required for a complete and operable signal distribution system shall be provided. Components shall be labeled in accordance with ANSI/TIA/EIA-606. Penetrations in fire-rated construction shall be firestopped in accordance with Section 07840 FIRESTOPPING. Conduits, outlets and raceways shall be installed in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. Wiring shall be installed in accordance with ANSI/TIA/EIA-568-A and as specified in Section 16415 ELECTRICAL WORK, INTERIOR. Wiring, and terminal blocks and outlets shall be marked in accordance with ANSI/TIA/EIA-606. Cables shall not be installed in the same cable tray, utility pole compartment, or floor trench compartment with ac power cables. Cables not installed in conduit or wireways shall be properly secured and neat in appearance and, if installed in plenums or other spaces used for environmental air, shall comply with NFPA 70 requirements for this type of installation.

3.1.1 Horizontal Distribution Cable

The rated cable pulling tension shall not be exceeded. Cable shall not be stressed such that twisting, stretching or kinking occurs. Cable shall not be spliced. Fiber optic cables shall be installed either in conduit or through type cable trays to prevent microbending losses. Copper cable not in a wireway shall be suspended a minimum of 8 inches above ceilings by cable supports no greater than 60 inches apart. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 inches shall be maintained when such placement cannot be avoided. Cables shall be terminated; no cable shall contain unterminated elements. Minimum bending radius shall not be exceeded during installation or once installed. Cable ties shall not be excessively tightened such that the transmission characteristics of the cable are altered. In raised floor areas, cable shall be installed after the flooring system has been installed. Cable 6 feet long shall be neatly coiled not less than 12 inches in diameter below each feed point in raised floor areas.

3.1.2 Riser and Backbone Cable

Vertical cable support intervals shall be in accordance with manufacturer's recommendations. Cable bend radius shall not be less than ten times the outside diameter of the cable during installation and once installed. Maximum tensile strength rating of the cable shall not be exceeded. Cable shall not be spliced.

3.1.3 Telecommunications Outlets

3.1.3.1 Faceplates

As a minimum each jack shall be labeled as to its function and a unique number to identify cable link.

3.1.3.2 Cables

Unshielded twisted pair and fiber optic cables shall have a minimum of 6 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturers bend radius for each type of cable shall not be exceeded.

3.1.3.3 Not Used

3.1.4 Terminal Blocks

Terminal blocks shall be mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Industry standard wire routing guides shall be utilized.

3.1.5 Not Used

3.1.6 Not Used

3.1.7 Equipment Racks

Open frame equipment racks shall be bolted to the [floor] [floor slab]. Cable guides shall be bolted or screwed to racks. Racks shall be installed level. Ganged racks shall be bolted together. Ganged rack cabinets shall have adjacent side panels removed. Wall mounted racks shall be secured to the mounting surface to prevent fully loaded racks from separating from the mounting surface.

3.1.8 Rack Mounted Equipment

Equipment to be rack mounted shall be securely fastened to racks by means of the manufacturer's recommended fasteners.

3.2 TERMINATION

Cables and conductors shall sweep into termination areas; cables and conductors shall not bend at right angles. Manufacturer's minimum bending radius shall not be exceeded. When there are multiple system type drops to individual workstations, relative position for each system shall be maintained on each system termination block or patch panel.

3.2.1 Not Used

3.2.2 Shielded Twisted Pair Cable

Each cable shall be terminated on panel-mounted connectors. Cables shall be grounded at patch panels using manufacturer's recommended methods. Shield braid shall be continuous to connector braid terminator. Wire insulation shall not be damaged when removing shield.

3.2.3 Not Used

3.2.4 Not Used

3.3 GROUNDING

Signal distribution system ground shall be installed in the telecommunications entrance facility and in each telecommunications closet in accordance with ANSI/TIA/EIA-607 and Section 16415 ELECTRICAL WORK, INTERIOR. Equipment racks shall be connected to the electrical safety ground.

3.4 NOT USED

3.5 NOT USED

3.6 TESTING

Materials and documentation to be furnished under this specification are subject to inspections and tests. All components shall be terminated prior to testing. Equipment and systems will not be accepted until the required inspections and tests have been made, demonstrating that the signal distribution system conforms to the specified requirements, and that the required equipment, systems, and documentation have been provided.

3.6.1 Not Used

3.6.2 Category 5e Circuits

All category 5e circuits shall be tested using a test set that meets the Class II accuracy requirements of TIA/EIA TSB 67 standard, including the additional tests and test set accuracy requirements of ANSI/TIA/EIA-568-A-5. Testing shall use the Basic Link Test procedure of TIA/EIA TSB 67, as supplemented by ANSI/TIA/EIA-568-A-5.. Cables and connecting hardware which contain failed circuits shall be replaced and retested to verify the standard is met.

3.6.3 Shielded Twisted Pair

Wiring configuration shall be tested for continuity, opens, shorts, swaps and correct pin configuration; dc resistance both pair-to-pair and wire-to-shield shall be verified. Cable lengths shall be verified. Near end crosstalk shall be tested from 772 kHz to 300 MHz. Ground potential difference between wiring closets, ground potential difference between patch panel and wall outlet, and ground path resistance shall be tested per IBM GA27-3361-07.

3.6.4 Not Used

3.6.5 Not Used

-- End of Section --

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DIVISION 16 - ELECTRICAL

SECTION 16721

INTERCOMMUNICATION SYSTEM

05/99

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SECTION 16721

INTERCOMMUNICATION SYSTEM
05/99

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 50	(1996; Rev thru Oct 1997) Enclosures for Electrical Equipment

1.2 SYSTEM DESCRIPTION

The system shall be solid state, modular in design, and shall be of the wired type with a single master with remote stations as indicated.

1.2.1 Not Used

1.2.2 System Operation and Service Features

1.2.2.1 Control and Power Requirements

The system shall have a power switch and an associated pilot light for ON and OFF operations. A volume control at each station shall be used to regulate listening volume. System shall operate on 110-125 Vac, single phase, 60 Hz.

1.2.2.2 Not Used

1.2.2.3 Identification Plates

In addition to the manufacturer's standard identification plates, engraved laminated phenolic identification plates shall be provided for each component connection and terminal. Identification labels shall be 3-layer black on white on black, engraved to show white letters on a black background. Any warning or caution labels shall be 3-layered red on white on red, engraved to show white letters on red background. Control switches and knobs shall be clearly marked with their function and status. Identification strips for station selector switches shall be located to clearly identify remote and master stations and shall be protected by transparent plastic inserts.

1.2.2.4 Speaker/Handset Stations

At speaker/handset stations, lifting the handset shall automatically cut out the loudspeaker in the station and all conversation shall be carried through the handset.

1.2.2.5 Not Used

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. When used, a designation following the "GA" designation identifies the office that will review the submittal for the Government.

SD-04 Drawings

Intercommunication System; GA, ED.

Detail drawings shall consist of illustrations, schedules, performance charts, instructions, brochures, diagrams, catalog cuts, manufacturer's data, materials and equipment lists, and operational and general maintenance instructions. Detail drawings shall be submitted for the overall system and for each major component. Drawings shall illustrate how each item of equipment has been coordinated and will function properly in the system. Detail drawings shall include an overall system schematic indicating relationship of intercommunication units on one diagram and showing power source, system controls, impedance matches, plus number, size, and maximum lengths of interconnecting wires and indicate clearances required for maintenance and operation.

SD-09 Reports

Test Plan and Procedures; GA, RE.

Test plan and procedures for the acceptance test shall explain in detail step-by-step actions and expected results to demonstrate compliance with the requirements specified. The procedures shall also explain methods for simulating the necessary conditions of operation to demonstrate system performance.

Acceptance Tests; FIO, RE.

Upon completion and testing of the installed system, test reports shall be submitted in booklet form showing all field tests performed to adjust each component and to prove compliance with the specified performance criteria. Each test report shall include the final position of controls and operating mode of the system. The manufacturer, model number, and serial number of test equipment used in each test shall also be included.

SD-19 Operation and Maintenance Manuals

Intercommunication System; FIO, RE.

Six complete copies of operation manuals outlining the step-by-step procedures required for system start-up, operation and shutdown. The manuals shall include equipment layout and schematics of simplified wiring and control diagrams of the system as installed. Instructions shall include the manufacturer's name, model number, and a brief description of equipment and components, and their basic operating features.

Six complete copies of maintenance manuals listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides.

1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt and dust, or other contaminants.

1.5 VERIFICATION OF DIMENSIONS

The Contractor shall become familiar with the details of the work and working conditions, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancies before performing the work.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that have been in satisfactory use at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Identical Items

Items of the same classification shall be identical. This requirement includes equipment, modules, assemblies, parts, and components.

2.1.3 Not Used

2.2 TYPE 1 SYSTEM

Direct connected keyed intercommunication system shall accommodate 24 stations in any combination of master stations and remote stations. Master and remote stations shall be provided in the quantities indicated. Each master station shall selectively communicate with any other master station and any remote station by actuation of an appropriate selector switch.

2.2.1 Not Used

2.2.2 Not Used

2.2.3 Not Used

2.2.4 Not Used

2.3 NOT USED

2.4 NOT USED

2.5 SPEAKER ENCLOSURES

Speaker enclosures shall be compatible with the speakers specified and comply with UL 50.

2.6 TERMINALS

Terminals shall be solderless, tool-crimped pressure type.

2.7 COMMUNICATIONS WIRING

Type of signal and control circuit wire and number of conductors shall be provided as recommended by the intercommunication system manufacturer, and as necessary to provide a complete and operable system. Where required, cable shall be UL classified low smoke and low flame for use in air plenums in accordance with NFPA 70.

2.8 SURGE PROTECTION

Major components of the system such as Master Stations, Amplifiers, and Remote Stations, shall have a device, either internal or external, which shall provide protection against voltage spikes and current surges.

PART 3 EXECUTION

3.1 INSTALLATION

All system components and appurtenances shall be installed in accordance with the manufacturer's instructions and as specified and shown. Units to be mounted outside or subject to inclement conditions shall be weatherproof or be mounted in weatherproof enclosures.

3.1.1 Signal and Control Circuits Wiring

Signal and control circuits shall be installed in accordance with NFPA 70 and as indicated.

3.1.2 Not Used

3.2 GROUNDING

The connection of interfacing components shall be accomplished through the use of transformers and the tying of interconnecting lines to a unit ground bus at one end only. The ground and distribution ground buses shall be solid copper wire with insulating covering.

3.3 ACCEPTANCE TESTS

After installation has been completed, the Contractor shall conduct an acceptance test, using the approved test plan, to demonstrate that the equipment operates in accordance with specification requirements. The Contractor shall notify the Contracting Officer 14 days prior to the performance of tests. In no case shall notice be given until after the Contractor has received written approval of the test plans. The acceptance tests shall include originating and receiving messages at specified stations, at proper volume levels, without cross-talk or noise from other links or nondesignated units.

3.4 TRAINING

The Contractor shall conduct a training course for 8 members of the operating and maintenance staff as designated by the Contracting Officer. The training course will be given at the installation during normal working hours for a total of 1 day, 8 hours hours and shall start after the system is functionally complete but prior to final acceptance tests. The field instructions shall cover all of the items contained in the approved operating and maintenance instructions, as well as the demonstration of routine maintenance operations. The Contracting Officer shall be notified at least 14 days prior to the start of the training course.

-- End of Section --

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SPECIFICATION SECTION: **02226**

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			1.4	Seismic Specialist					X							X	ED									
			1.4	Blasting Specialist					X							X	ED									
			1.4	Blaster-In-Charge					X							X	ED									
			1.4	Foundation Excavation Plan									X			X	ED									
			1.4	Blasting Plan									X			X	ED									
			1.4	Special Excavation Plan									X			X	ED									
			1.4	Buffer Zone Excavation Plan									X			X	ED									
			1.4	Plan for Excavation Adjacent to Structures									X			X	ED									
			1.4	Blasting Work Plan									X			X	RE									
			1.4	Blast Vibration Monitoring Plan									X			X	ED									
			1.4	Safety Plan									X			X	RE									
			1.4	Pre-Blast Survey									X			X	RE									
			1.4	Blast Records									X			X	RE									
			1.4	Blast Notification									X			X	RE									

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CONTRACT NO.

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SPECIFICATION SECTION: **02741**

ACTIVITY NO. a.	TRANSMITTAL NO. b.	ITEM NO. c.	SPECIFICATION PARAGRAPH NUMBER d.	DESCRIPTION OF ITEM SUBMITTED e.	TYPE OF SUBMITTAL: DATA f.	DRAWINGS g.	INSTRUCTIONS h.	SCHEDULES i.	STATEMENTS j.	REPORTS k.	CERTIFICATES l.	SAMPLES m.	RECORDS n.	O & M MANUALS o.	CLASSIFICATION: INFORMATION ONLY p.	GOVERNMENT APPROVED q.	REVIEWER r.	CONTRACTOR SCHEDULE DATES: SUBMIT s.	APPROVAL NEEDED BY t.	MATERIAL NEEDED BY u.	CONTRACTOR ACTION: CODE v.	DATE w.	SUBMIT TO GOVERNMENT x.	GOVERNMENT ACTION: CODE y.	DATE z.	REMARKS aa.
			1.3	Aggregates						X						X	RE									
			3.10.3.10	QC Monitoring						X					X											
			1.3	Aggregate and QC test results						X					X											
			2.2	Asphalt Cement Binder							X					X	RE									
			1.3	Copies of certified test data							X				X											
			3.6	Testing Laboratory							X					X	RE									
			1.3	Certification of compliance							X				X											
			1.3	Plant Scale Calibration Certification							X				X											
			2.2	Asphalt Cement Binder								X			X											
			1.3	Aggregates								X			X											
			2.3	Mix Design									X			X	RE									
			1.3	Proposed JMF									X			X	RE									
			3.10	Contractor Quality Control									X			X	RE									
			1.3	Quality control plan									X			X	RE									
			1.3	Material Acceptance and Percent Payment:									X			X	RE									
			1.3	Acceptance test results and pay calculations									X			X	RE									

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SPECIFICATION SECTION
11150

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			1.2	Gate Operator SystemS	X											X	RE									
			1.2	Cantilever Slide and Swing Gate Systems instructions.			X																			
			1.2	Cantilever Slide and Swing Gate System O&M Manuals										X												

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a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.	m.	n.	o.	p.	q.	r.	s.	t.	u.	v.	w.	x.	y.	z.	aa.
			2.1	Electric unit heaters	X											X	ED									
			3.1	Heater installation drawing		X										X	RE									
			2.1	Electric unit heaters										X		X	ED									

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SPECIFICATION SECTION
16710

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a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.	m.	n.	o.	p.	q.	r.	s.	t.	u.	v.	w.	x.	y.	z.	aa.
			1.5	Spare Parts	X											X	ED									
			1.5	Premises Distribution System		X										X	ED									
			1.5	Record Drawings		X										X	RE									
			1.5	Manufacturer's Recommendations			X									X	ED									
			1.5	Test Plan					X							X	RE									
			1.4	Qualifications					X							X	RE									
			1.5	Test Reports						X						X	ED									
			1.5	Premises Distribution System							X				X											
			2.1	Materials and Equipment							X				X											
			1.5	Installers							X					X	RE									
			1.5	Record Keeping and Documentation									X			X	RE									

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CONTRACTOR

SPECIFICATION SECTION: **16721**

ACTIVITY NO (a.)	TRANSMITTAL NO. (b.)	ITEM NO (c.)	SPECIFICATION PARAGRAPH NUMBER (d.)	DESCRIPTION OF ITEM SUBMITTED (e.)	TYPE OF SUBMITTAL: DATA (f.)	DRAWINGS (g.)	INSTRUCTIONS (h.)	SCHEDULES (i.)	STATEMENTS (j.)	REPORTS (k.)	CERTIFICATES (l.)	SAMPLES (m.)	RECORDS (n.)	O & M MANUALS (o.)	CLASSIFICATION: INFORMATION ONLY (p.)	GOVERNMENT APPROVED (q.)	REVIEWER (r.)	CONTRACTOR SCHEDULE DATES: SUBMIT (s.)	APPROVAL NEEDED BY (t.)	MATERIAL NEEDED BY (u.)	CONTRACTOR ACTION: CODE (v.)	DATE (w.)	SUBMIT TO GOVERNMENT (x.)	GOVERNMENT ACTION: CODE (y.)	DATE (z.)	REMARKS (aa.)
			1.3	Intercommunication System		X										X	ED									
			1.3	Test Plan and Procedures						X						X	RE									
			3.3	Acceptance Tests						X					X											
			1.3	Intercommunication System										X	X											